TECHNICAL DUE DILIGENCE FOR THE ALFA SOLAR PROJECT IN UKRAINE

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LIST OF ACRONYMS AND ABBREVIATIONS

Abbreviation	Meaning
AC/DC	Alternating Current and Direct Current. AC is a type of electrical current, which direction is reversed at regular intervals or cycles. Electricity transmission networks use AC, because voltage can be controlled with relative ease. DC has a constant direction, and is produced by the PV modules.
Azimuth angle	The angle between the site location's meridian and the PV module plane. This angle is taken as negative towards the East, i.e. it has a trigonometric direction. The above is only applicable within the Southern Hemisphere.
BIPV	Building integrated Photovoltaic.
BOS	Balance of System – the PV system equipment excepted the PV module
c-Si	Crystalline Silicon
EIS	Environmental Impact Study
EMC	Electromagnetic Compatibility
EPFI	Equator Principles Financing Institution
EPC	Engineering Procurement Construction
ERP	Enterprise Resource Planning (software)
GHI	Global Horizontal Irradiation
G_{INC}	Global Irradiation on the Inclined Plane
GL GH	GL Garrad Hassan
IEC	International Electrotechnical Committee
ISO	International Organisation for Standardisation
MPP and MPPT	MPP is the Maximum Power Point - the point on the current-voltage (I-V) curve of a module under illumination where the product of current and voltage is at its maximum. MPPT refers to the inverter tracking algorithm for following the MPP.
NOCT	Nominal Operating Collector Temperature. This is the temperature attained by the PV modules, without back coverage under the standard operating conditions, defined as: 800 W/m^2 of irradiation, 20ºC of ambient temperature, 1 m/s of wind speed, and open circuit.
PPA	Power Purchase Agreement
PR	The Performance Ratio (PR) is an international measure for describing the level of utilization for an entire PV system. The PR is a fraction of useful energy (at the feed-in point) in the nominally producible energy volume which results from the module surface area, the module efficiency (according to the data sheet), and the irradiation incident on the module surface.
RMU	Ring-Main Unit

Abbreviation	Meaning
SHOB	Surface Hors Oeuvre Brut (ground surface, less the wall section)
SPV	Special Purpose Vehicle
UAH	Ukrainian Grivna (local money) 1 UAH = €0.092081
Wp, kWp, MWp	Watt, kilowatt or megawatt peak. The peak power is the PV module's power output under the standard test conditions (STC), i.e. operating temperature of 25ºC, in full sunshine (irradiance) and at 1.000 W/m^2, and AM 1.5.

1 EXECUTIVE SUMMARY

GL Garrad Hassan Ibérica ("GL GH") has been contracted by VTB Capital ("the Client") to undertake the Technical Due Diligence of the 80 MWp solar photovoltaic (PV) plant ("the Project"), to be constructed in the Peninsula of Krimea in Ukraine, close to Simferopol city. The Project is being developed by Activ Solar ("the Developer") in four phases of 20 MW each. These phases are called: Alfa Solar, Beta Solar, Gamma Solar and Zeta Solar. The present report refers to the Alfa Solar phase, corresponding to a quarter of the total installed capacity of the project.

The main contents of this report are listed below:

- Technology review (PV module and inverter);
- Contract review (PV module supply contract, Balance of Plant contract and O&M contract);
- Time schedule review; and
- Technical inputs to the financial model.

The following contents for the entire project have been assessed in a separate GL GH report, [2.1] and [2.2]:

- Site layout review;
- High level design technical review; and
- Independent energy assessment.

The executive summary is providing the main findings of the Due Diligence performed by GL GH. The Table 1.3 and Table 1.4 can be found at the end of this Section providing the outstanding issues and the GL GH recommendations. In addition, the outstanding information has been highlighted in bold and italic in further sections.

1.1 Technical Review of the Technology Proposed for the PV Plants

GL GH has reviewed the proposed technology for the PV plant, focussing on the PV modules, the inverters and the manufacturers' capability.

The PV plants will consist of polycrystalline silicon technology. Three PV module manufacturers are considered in this review:

- Jinko Solar
- CNBM International Corp
- Hyundai Heavy Industries (HHI)

Jinko Solar:

This China based manufacturer entered the solar module industry in 2006 principally as a silicon ingot manufacturer. It began producing its own modules in 2009. By 2010, annual solar module production capacity reached 600MWp annually which is substantial production capacity among module producers.

The designated Jinko Solar module to be deployed is the JKM225P-60 polycrystalline module with peak power of 225 Wp.

The JKM225P-60 has an electrical efficiency of 13.74% which is typical of for this module type. Also, the electrical parameters and temperature coefficients are standard for a PV module of this type. The PV module is certificated under the IEC 61215 and IEC 61730 (Parts 1&2), and it meets the CE mark requirements. The corresponding TüV certificates have been provided (see details in Section 3.1.9).

Regarding quality and environmental management, Jinko Solar is certified under ISO 9001: 2008 and 14001: 2004, respectively. GL GH considers these certifications as a PV manufacturer are needed to support the control quality of the IEC certification. The problem with these certifications is that the number of units manufactured per year is extremely high (more than 2.5 million modules per year) compared to the number of modules inspected by third parties (less than one hundred). Therefore, the internal quality procedure checked independently as provided in a Bankability report of the technology is the only mitigation factor for the identified risk.

Jinko Solar performance warranty slightly exceeds industry standards. Jinko Solar gives a product warranty for their modules of 5 years, which is pretty much standard in the market. In addition, as of June 2011, the company has contracted with PowerGuard Speciality Insurance Services which offers non-cancellable product insurance coverage through the first 5 years of product service, subsequently followed by a tiered performance guarantee out to 25 years.

The production of Jinko Solar's PV modules is sold to a wide variety of global customers and is utilized in residential, commercial and utility scale PV systems. The list of references at a commercial or utility scale undertaken by Jinko Solar counts 22 projects under construction or already connected with a total power of 70 MWp.

A Bankability report for Jinko Solar technology has not been provided. However, Jinko Solar did provide a letter from the leasing arm of UniCredit indicating that it considers TUV IEC61215 certified Jinko Solar PV modules to be "bankable" for projects financed by UniCredit, subject to project specific review by their credit committees. This is not a fully mitigation factor comparable to a Bankability report for the risk derived from the short track record but it is a positive indicator.

Though it is considered that polycrystalline technology has an acceptable track record and operating history, GL GH recommends that the Sponsor confirms with Jinko Solar that:

- All the suppliers for project modules are the same than the one mentioned in the TUV Rheinland IEC 61215:2005 certificates, in particular the cell supplier. In that sense, the fully traceability of the components of each module would be necessary to check that. GL GH recommends confirming with Jink Solar the degree of traceability of the components; and
- All Jinko Solar PV modules follow exactly the same manufacturing process, in order to be comfortable that their performance and conformance to IEC standards will be consistent.

By procuring such information supporting the quality and the origin of the technology, GL GH would consider that the associated technical risk of using Jinko Solar technology remains small to moderate. If a positive Bankability report is provided then the risk would be small.

CNBM Solar:

This China based manufacturer entered the PV industry in 2005. According to the firm, it has an annual production capacity of 220 MW. However, it appears that CNBM may also contract with other established PV module manufacturers and then “brands” the modules CNBM. This is something usual in the PV module value chain.

The CNBM Solar production is divided between mono-crystalline, poly-crystalline and thin film amorphous silicon modules. The 220 MW capacity places it as a mid-size player in the global solar PV industry.

The designated CNBM Solar module to be deployed is the CNBM 230P poly-crystalline module with a peak power of 230 Wp.

The CNBM 230P has a calculated electrical efficiency of approximately 14% which is typical of for this module type. Also, the electrical parameters and temperature coefficients are standard for a PV module of this type. The PV module is certificated under the IEC 61215 and IEC 61730 (Parts 1&2), and it meets the CE mark requirements. The corresponding TüV certificates have been provided.

Regarding quality and environmental management, CNBM International is certified under ISO 9001: 2008 but not 14001: 2004. GL GH considers these certifications as a PV manufacturer as needed to support the control quality of the IEC certification. The problem with these certifications is that the number of units manufactured per year is extremely high (almost 1 million modules per year) compared to the number of modules inspected by third parties (less than one hundred). Therefore, the internal quality procedure checked independently as provided in a Bankability report of the technology is the only mitigation factors for the identified risk.

CNBM Solar performance warranty matches industry standards. CNBM Solar gives a product warranty for their modules of 5 years, which is pretty much standard in the market. The production of CNBM PV modules is sold to a variety of global customers and is utilized in variety of PV system types. However a list of references at commercial or utility scale that utilize CNBM modules has not been provided.

A Bankability report for CNBM Solar technology has not been provided.

Though it is considered that polycrystalline technology has an acceptable track record and operating history, GL GH recommends that the Sponsor confirms with CNBM Solar that:

- CNBM is in fact the manufacturer and supplier of all project modules are the same model numbers as are referenced in the TUV Rheinland IEC 61215:2005 certificates. In that sense, the fully traceability of the components of each module would be necessary to check that. GL GH recommends confirming with CNBM Solar the degree of traceability of the components; and
- All CNBM PV modules follow exactly the same manufacturing process, in order to be comfortable that their performance and conformance to IEC standards will be consistent.

By procuring such information supporting the quality and the origin of the technology, GL GH would consider that there is a moderate level of technical risk of using CNBM Solar technology.

Hyundai Heavy Industries (HHI):

This Korean based manufacturer entered the solar module industry in 2008 principally as a silicon PV cell manufacturer. It began producing its own modules in 2009. By 2010, annual solar module production capacity reached 270 MW annually which is an intermediate production capacity among global module producers.

The designated HHI Solar module to be deployed is a poly-crystalline module with peak power of 230 Wp.

The HHI module has an electrical efficiency of 14.2% which is typical of for this module type. Also, the electrical parameters and temperature coefficients are standard for a PV module of this type. The PV module is certificated under the IEC 61215 and IEC 61730 (Parts 1&2), and it meets the CE mark requirements.

Regarding quality and environmental management, HHI is certified under ISO 9001: 2008 and 14001: 2004, respectively. GL GH considers these certifications as a PV manufacturer as needed to support the control quality of the IEC certification. The problem with these certifications is that the number of units manufactured per year is extremely high (more than 1.1 million modules per year) compared to the number of modules inspected by third parties (less than one hundred). Therefore, the internal quality procedure checked independently as provided in a Bankability report of the technology is the only mitigation factor for the identified risk.

HHI Solar performance warranty is in line with exceeds industry standards. HI Solar gives a product warranty for their modules of 5 years, which is pretty much standard in the market.

The production of HHI PV modules is sold to a wide variety of global customers. The modules are utilized in residential, commercial and utility scale PV systems. The small list of references provided by HHI of commercial or utility scale projects that utilize HHI PV modules counts 8 completed projects varying in size from 0.5 MW to 8.5 MW.

A Bankability report for HHI technology has not been provided.

Though it is considered that polycrystalline technology has an acceptable track record and operating history, GL GH recommends that the Sponsor confirms with HHI Solar that:

- HHI is in fact the manufacturer and supplier of all project modules are the same model numbers as are referenced in the TUV Rheinland IEC 61215:2005 certificates. In that sense, the fully traceability of the components of each module would be necessary to check that. GL GH recommends confirming with CNBM Solar the degree of traceability of the components; and
- All HHI PV modules follow exactly the same manufacturing process, in order to be comfortable that their performance and conformance to IEC standards will be consistent.

By procuring such information supporting the quality and the origin of the technology, GL GH would consider that the associated technical risk of using HHI Solar technology to be moderate.

Inverters:

The PV plants included in the portfolio are using a single inverter supplier: AEG Power Power Solutions. This supplier is presented in the following section.

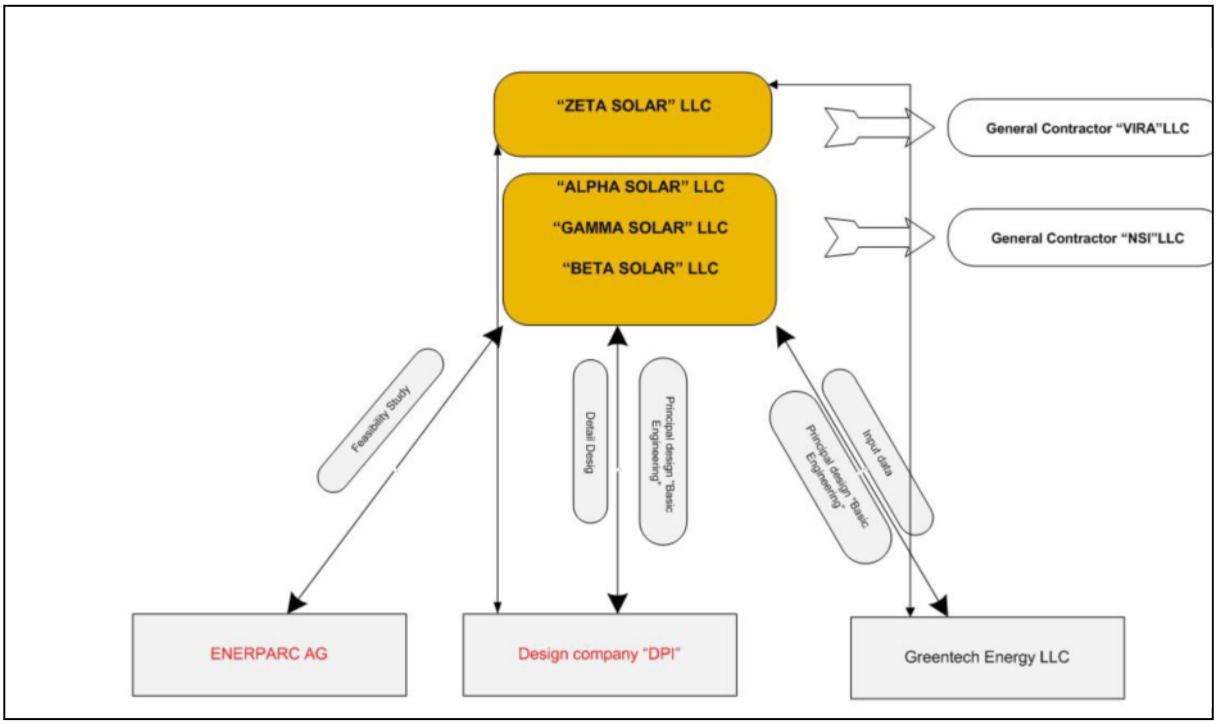
AEG Power Solutions Inverters:

The technical specifications of the inverters supplied to the project are broadly similar to the market equivalent products. The MPPT voltage range is 450 - 820 V, which is in the expected range for this type of inverter.

No Bankability report on this supplier has been made available by the Client. The AEG Power Solutions utility scale PV inverter technology was introduced to the market in September 2009 via its Protect PV 250 inverter line. However, AEG Power Solutions has a long history in the electronics industry and power control industry. Their products present the typical quality certificates and they have an acceptable, if not above industry standard, efficiency level. Therefore, GL GH considers that the technical risk associated with this inverter supplier is small.

1.2 Contract Review

The Project is divided into four phases of 20 MW. Each phase is constructed through a dedicated SPV, following the same contractual scheme as shown in Figure 1.1, below. This analysis is focused on the Alpha Solar PV plant.



Source: Activ Solar. *GL GH notes that Greentech is not presented as the O&M contractor and Activ Solar trading equipment delivery contract is missing.*

Figure 1.1: Contractual organisation

GL GH has reviewed the following contracts:

- Engineering Contract - signed between “Dneprovtsky Proentny Institut” (DPI) and Alpha Solar and dated 02 September 2010.
    - Field Supervision During Construction Contract between DPI and Alpha Solar, dated 23rd March 2011.
- Construction Contract between NSI Bud and Alfa Solar, dated 25 November 2011.
- Cables Procurement Contract, between Activ Solar Trading and Alpha Solar, dated 18 November 2010.
    - Addendum to this contract, dated 17 March 2011.
- Mounting Structures Procurement Contract, between Activ Solar Trading and Alpha Solar, dated 18 November 2010.
    - Addendum to this contract, dated 28 March 2011.
    - Addendum to this contract, dated 01 June 2011.
- Contract of Equipment Delivery, between AST Activ Solar Trading and Alfa Solar LLC and dated 18 November 2010.
- Operation and Maintenance Draft and its Appendices. This document is in progress and the contractor will be GreenTech Engineering LLC, providing O&M services to Alpha Solar.

The different contractors are listed below:

- Activ Solar Trading is the main contractor of the Alpha Solar SPV. The company is delivering all main components as well as engineering and support. It a subsidiary of Activ Solar GmBH, Activ Solar being the Sponsor of the Project.
- DPI is the engineering company adapting the basic engineering into the Ukrainian standards, surveying the works progress on site and issuing the as built documentation.
- NSI is the company that will construct the Project.
- Green Tech will be the contractor for the Operation phase. The contract is in progress and not signed yet.

The above contractual structure has been also used for the first large scale Ukrainian PV project (7.5 MW), sponsorised by Activ Solar, and commissioned in January 2011. The responsibility of each contractor during the construction phase is further described in Table 1.1.

GL GH has reviewed the overall structure of the contracts and the conclusions extracted from the review for the construction and operation phases of the project are presented below. The recommendations made in this section are based on best practice in the industry.

Construction Phase:

In order to achieve the construction of the Alpha Solar Project, several contractors are engaged through different contracts. Table 1.1, below, is a summary of the responsibilities and interactions within the contracts reviewed. For all these contracts, the Client is Alpha Solar. In Table 1.1, the sign “X” shows the contractor/company that will do the work or provide the service indicated on the left. The sign “i” indicates that the fault of the party responsible for the tasks may implicate another subcontractor and possibly reduce its responsibility to Alpha Solar. It is understood that Alpha Solar is implicated in all tasks. Finally, the sign “?” is drawn when the tasks are part of the contract but remain unclear. When the tasks indicated in the matrix are not part of any contract reviewed, GL GH assumes that Alpha Solar was ultimately responsible for these.

	Alpha Solar	Activ Solar Trading	DPI	NSI
Development	X			
Basic Engineering		X	i	
Engineering integration		i	X	i
As-built documentation		i	X	i
Site preparation	X			
Project management	X			
Delivery of modules, inverter stations, cables and mounting system		X	i	i
Grid connection	X			
Construction		i	i	X
Supervision during construction		i	X	i
Support for construction, commissioning and training		X	i	i
Completion		X	i	i
Construction warranty: 12 months		i		X
Mechanical warranty: 24 months		X		
PR warranty		?		
Availability warranty	O&M			
Contingencies during construction	X			
Inverters warranty	O&M?	?		
Module warranty		?		

Table 1.1: Responsibility matrix

Activ Solar GmBH, which is the Owner of Alpha Solar, is using the services of Activ Solar Ukraine and Activ Solar GmBH for the development of the project, as well as for coordination and management during construction. This relationship is not formerly written into any contract.

GL GH highlights the main risks of the contractual structure in the following paragraphs and gives its recommendations for minimising these risks. It is obvious that the risks would be mitigated optimally if the table above would have no “i” and no “?”.

Overall warranties

The warranties that are provided by the main contract and detailed in the section 4.5.4 of that report are not sufficient. It is summarised in Table 1.2 below. Moreover, there is no warranty provided by the cable and mounting systems contracts. This is not acceptable.

Finally, the method for transferring the warranties from the manufacturers of main components to the SPV is not detailed in the contract. For instance, no 25-year power warranty for PV modules has been included in any of the contracts reviewed.

Equipment	**Warranty Period**
PV modules, inverter containers, junction boxes, monitoring stations	2 years - ***unclear***
Cables, mounting systems	**Missing**
Standard material manufacturer warranties (modules, inverters)	**Not provided**
Construction	**Warranty Period**
Construction works	12 months
Performance	**Warranty Period**
Availability	Missing
Performance ratio	**Missing**

Table 1.2: Construction warranties

Price

The contract price is fixed for the Activ Solar trading contracts. Some recommendations have been made in section 4.5.2. The other contracts do not have fixed prices and several extensions of the work could be expected during the construction of the project; this is a risk to the project budgets. Moreover, as it is highlighted in the financial model (see section 6.3), the CAPEX costs are not all covered by the contracts provided for review.

Responsibilities

Given the number of contractors and the relationships between the Sponsor and the different contractors, many responsibilities are shared - as is shown in Table 1.1. Indeed, each time that an operation made by a subcontractor implicates another subcontractor, the potential defect (such as delay, a broken part or an error in design) arising from this operation could lead either to minimising or to dismissing the responsibility of the other contractor implicated. Ultimately, the Sponsor may not be covered and will be subject to price increases or a lack of warranty.

Conclusion and identification of mitigation factors:

GL GH understands that the same contractual structure has led to the 7.5 MWp Rodnikovoye PV plant, commissioned in February 2011 (the first part of 2.5 MWp was commissioned in September 2010). This plant is the largest Ukrainian PV Plant commissioned, to date. However, this project is not subject to this Due Diligence analysis and no information about its operation and construction quality has been provided.

In the particular case of the Alpha Solar project, the risk of the construction relationships and responsibilities can be mitigated, since the works show progress of around 90 % on-site based on the figures provided by the Sponsor. GL GH has not been provided with detailed progress reports, but some pictures of the ongoing Alpha Project have been made available by Activ Solar. However, since this report will be used for the remaining contractual scheme of the 80 MW project in Perovo, this mitigating factor is applicable to the Alpha Solar project only.

To comply with market best practice, GL GH would suggest one of the following solutions:

(i) Activ Solar Trading, who is the main contractor (up to 90 % of the CAPEX engaged in his invoices) becomes the real EPC contractor and subcontracts everything, in order to deliver a turn key contract;

(ii) A new contract between the SPV Alpha Solar and Activ Solar Gmbh, or one of its subsidiary, is created to cover the tasks under the SPV responsibilities and not part of the EPC contract;

In both cases, the risks defined above can be mitigated by adding the following conditions:

- Enclosing the recommendations made in the previous sections, paying particular attention to the completion and warranty conditions;
- Enclosing a provision for contingencies in the Financial Agreement, thereby limiting the CAPEX engagement for the Lenders;
- The transfer of ownership and warranties should be clearly identified in the contracts;
- Since the O&M contractor and the EPC contractor are different, the EPC contractor should be responsible for training the O&M contractor and for delivering a "Certificate to operate", covering the Sponsor for disagreement between the O&M contractor and the EPC contractor during the PR warranty given by the EPC contractor.

Operation phase:

The main recommendation for the O&M contract would be to give more responsibility to the O&M contractor from the commencement of the contract. The contract contains many unbinding references, such as, "the contractor will do what is reasonably possible". In order to give the Contractor more responsibility, the implication of the Contractor could start from initial energisation of the project with:

- Acceptance of the test results;

- Validation of the punch list;

- Training of the operator, with delivery of the certificate to operate from the Builder;

- Participation in the definition of the spare part minimum initial stock.

Following this approach, the Contractor shall be liable for the warranties that will be required during the PV plant operation. Plus, the warranties shall not be weakened by too many conditions relying on the Sponsor, such as the minimum spare part modification clause in section 2.3, paragraph 3. This clause allows the O&M contractor to be relied of its responsibility if the Sponsor does not agree on the spare part stock modification and it is not acceptable.

GL GH also notes two major clarifications that need to be included in the contract, which are:

- The inverter replacements and warranty detailed (see section 4.7.1) need to be clarified;
- The module replacement risks (see section 4.7.1) need to be covered by a provision in the OPEX.

GL GH considers that the risks associated with the contractual structure of the project for O&M and construction is high.

1.3 Review of the Construction Schedule

The project program shows the different tasks, as well as the material delivery to achieve the construction. All the main tasks required to undertake the construction of a PV plant have been identified in that document, even if GL GH would have expected more detailed planning with subtasks and predecessors.

The project construction duration is estimated to be three months; this seems to be quite an optimistic time schedule for a 20 MW PV plant. GL GH considers that the construction schedule should be updated to take into account the previous comment and correspond to the announced completion date.

The Alpha Solar Project is part of a greater portfolio of four projects. These projects are connected to the same substation: “Tavria Substation”. No information has been provided to GL GH about the time schedules for grid connection and for the Tavria Substation to be erected. ***Therefore, evidence of the integration of Alpha Solar into more general planning should be provided.*** Moreover, GL GH anticipates difficulties in the construction works for the other project being built during the winter season, which should be reflected in the other SPV’s Time Schedule (such as trenching under 5°C).

Finally, there are no milestones attached to the planning. The different contracts reviewed each have different payment conditions. The main contract for the project’s costs is the Contract of Equipment Delivery which represents 92 % of the CAPEX. The payment is based on the delivery of the material on site. Therefore, if the Sponsor wants to store the modules on-site, it needs to pay 92 % upfront, otherwise the drawdown will follow the pace of the progress of the work on-site. GL GH recommends linking part of the equipment contract payment to the validation of the Provisional Acceptance. A minimum of 5-10 % is considered to be the market standard.

1.4 Review of the Technical Inputs to the Financial Model

Energy yield:

The Energy Production Assessment for the entire portfolio has been divided into two phases. GL GH is going to detail the calculation and results for the P50 and P90 in two separated reports ([2.1] and [2.2]).

The irradiation used in the financial model is 1,442 kWh/m². It is referred as “Horizontal Global Irradiation” provided by Enerparc. There is some confusion between “yield” and “irradiation” in the reviewed document. The yield presented in ENERPARC’s (subcontracted to SOLPEG) report is 1,331 kWh/kWp. Moreover a loss factor of 0.97 % is applied without further explanations.

The main results of the GL GH analysis ([2.1] and [2.2]) are provided below:

- Global Horizontal irradiation: 1,344 kWh/m²
- Irradiation on the inclined plane: 1,486 kWh/ m²
- Energy Yield Factor: 1,109 kWh/kWp
- Performance Ratio: 74.6%

It is concluded that the difference in the between the financial model energy yield and the GL GH estimation is approximately 20%.

Feed-in tariff:

The feed-in tariff used in the financial model for the calculation is estimated to be €0.4653/kWh and the price is constant for 18 years. No supporting information has been provided to GL GH for this review. GL GH notes that this tariff is really high compared to other international feed-in tariffs or incentive system that can be found in countries where PV electricity production is well consolidated.

CAPEX review:

The financial model [3.2] is not supported by the contracts reviewed. Therefore, GL GH received complementary information [6.1] from Activ Solar in order to have a better understanding of the financial model and the corresponding contractual structure. For the purpose of clarification, the CAPEX review has been carried out in three steps: (i) A review of the financial model, based on the industry practice; (ii) A presentation of the costs in the contracts and GL GH's understanding of the coverage of these contracts; (iii) A review of the different costs and tasks with the Sponsor and comments on missing information to support the hypothesis provided.

GL GH's main comments on the CAPEX, after analysis of the documents provided, are as follows:

- The different tasks listed in the financial model cover the CAPEX of a standard PV plant;
- The minimum stock of spare parts is not included in the CAPEX. ***It should be clarified if this is included in the CAPEX or in the OPEX, since it is paid by the Sponsor***;
- The complementary document does not prevent the Sponsor providing a contract addendum, or new contract, detailing the tasks covered by Active Solar and included in the financial model. ***The documents and contracts, specifying the tasks undertaken by Active Solar and part of the financial model breakdown, should be provided to GL GH for review***;
- The works and local equipment tasks and subtasks are not covered by a specific contract. Therefore, the risk of cost exceedance due to these tasks still exists;
- The total capital in the financial model reaches €3.33/Wp when it reaches €3.66 /Wp, after review of the complementary information. Both figures are high for a PV projec compared to the market standard. Moreover, GL GH recommends enclosing a provision for contingencies in the financial agreement, thereby limiting the CAPEX engagement for the Lenders.

OPEX review:

GL GH has not been provided with supporting information to enable it to comment on the OPEX costs, such as contracts and land leases, for example. Nevertheless, GL GH would comment on the OPEX figures, as follows:

- The list of tasks seems comprehensive, mainly because the maintenance tasks and material costs could cover a wide range of services;
- ***The electricity for own consumption should be clarified, since it seems to be rather a unusual very high cost***;
- The insurance costs are expected to be around 1.5 %, or the yearly revenue of the Plant, depending on the insurance contracted. Given the very high feed-in tariff GL GH considers that this cost is higher than expected in other European countries. GL GH recommends that the Insurance Advisor also checks this figure;

- The land lease cost seems to be rather low (around 50 times lower than a western European country's cost). ***The land lease contract should be provided to GL GH for review, in order to check these costs***;
- The OPEX figure of €30.85/kWp seems to be very low, compared to the market standards;
- The contingencies provision represents 1 % of the OPEX, when it would usually be expected to be around 10 %;
- The costs of this model should be supported by the contracts that will be eventually signed; and
- Two important and specific tasks should be reviewed when the O&M contracts are finalised (see section 4.7):
    - *Inverter replacements and warranty management.* It should be clarified which option or a combination of them is going to be considered: (i) The inverter replacements are included in the O&M contract; (ii) There is contract between the Sponsor and the inverter manufacturer; (iii) The inverter replacements are covered by a maintenance reserve account (MRA) and when the contract covering the inverter replacement is limited, the MRA should be prepared for the end of the agreement.
    - *Module replacement management.* Since this is not included in the O&M contract, this has to be addressed by means of an adequate initial stock and the labour cost for replacement,

1.5 Recommendation and Outstanding Information Tables

The tables below summarise all the GL GH recommendations and all outstanding information.

Table 1.3, below, summarizes the outstanding issues [A: Very critical; B: Moderate; C: Not Critical].

Item	Subject	Contractor	Section	Outstanding information	Critical Level
1	Technology		3.1.5	No specific information on the internal quality control of Jinko has been provided.	A
2	Technology		3.1.5	GL GH has no access to information regarding the historic performance of Jinko PV modules, this should be provided.	A
3	Technology		3.1.5	Jinko Solar module warranty should be provided	A
4	Technology		3.1.6	CNBM should provide confirmation that they are the module's manufacturer.	A
5	Technology		3.1.8	CNBM should confirm that their ISO 9001 certification applies specifically to CNBM manufactured PV modules	A
6	Technology		3.1.10	CNBM should provide IEC certification test reports	A
7	Technology		3.1.10	No specific information on the internal quality control of CNBM has been provided.	A
8	Technology		3.1.10	GL GH has no access to information regarding the historic performance of CNBM PV modules, this should be provided.	A
9	Technology		3.1.14	Hyundai needs to confirm part number and the reference of PV module	A
10	Technology		3.1.14	Hyundai should provide IEC certification test reports	A
11	Technology		3.1.15	No specific information on the internal quality control of Hyundai has been provided.	A
12	Technology		3.1.15	GL GH has no access to information regarding the historic performance of Hyundai PV modules, this should be provided.	A

Item	Subject	Contractor	Section	Outstanding information	Critical Level
13	Construction	NSI	4.2	The notion of serious damage in the construction contract should be clarified	B
14	Construction	DPI	4.3	They are two discrepancies in the DPI contract. The price and the reference of the contract should be corrected in the appendices.	C
15	Construction	Activ Solar Trading/Structures	4.4	In the Mounting system contract, the number of parts required for the 20 MW plant and its exact function in the mounting systems in the plant are not clear	B
16	Construction	Activ Solar Trading/Main	4.5.1	What is defined as direct lightning protection? And what would then be indirect lightning protection;	B
17	Construction	Activ Solar Trading/Main	4.5.1	The cables for modules and power station connection should be clarified.	A
18	Construction	Activ Solar Trading/Main	4.5.1	The cables for modules and power station connection should be clarified.	A
19	Construction	Activ Solar Trading/Main	4.5.1	The Certificate of acceptance of the Basic Engineering signed by Alpha Solar and DPI should be provided.	A
20	Construction	Activ Solar Trading/Main	4.5.1	The clarification on the project management during the operation should be provided to GL GH.	A
21	Construction	Activ Solar Trading/Main	4.5.2	The typo in schedule 1 of the contract about the acceptable range of modules delivered should be clarified.	A
22	Construction	Activ Solar Trading/Main	4.5.4	The Warranty calculation explained as output reached for the power is unclear. It should be clarified.	A
23	O&M	GreenTech	4.7.1&4.7.5&6.4	The replacement of the inverters is unclear during operation.	A
24	O&M	GreenTech	4.7.3	Typo: the section 7 title should be changed since two warranties are provided.	C
25	O&M	GreenTech	4.7.4	The invoice calculation detail appears twice in the contract (section 3.1 and section 3.2). It should be corrected.	C
26	Time Schedule	Alpha Solar/Activ Solar	5	The integration of Alpha Solar in a more general program should be provided	A
27	O&M/Construction	Activ Solar/GreenTech	6.3&6.4	It should be clarified if the initial stock of spare parts is included in the CAPEX or in the OPEX since it is paid by the Sponsor	A

Item	Subject	Contractor	Section	Outstanding information	Critical Level
28	Construction	Activ Solar	6.3	The documents and contracts specifying the tasks undertaken by Activ Solar and part of the financial model breakdown should be provided to GL GH for review	A
29	O&M	Activ Solar	6.4	In the O&M financial model, the Electricity for own consumption should be clarified since it seems rather high	B
30	O&M	Activ Solar	6.4	The land lease contract should be provided to check the associated cost	B

Table 1.3: Outstanding information table

Table 1.4, below, summarises GL GH's recommendations [A: Very critical; B: Moderate; C: Not Critical].

Item	Subject	Contractor	Section	GL GH Recommendations	Critical level
1	Technology		3.1.2	GL GH recommends that additional information from Jinko Solar regarding its activity of PV module production is provided	A
2	Technology		3.1.5	GL GH recommends to obtain: – Letter of acceptance for the specific plant design, issued by the PV module supplier; – Minimum requirements for the plant design, issued by the PV module supplier, and corresponding acceptance by the plant constructor;	A
3	Technology		3.1.7	GL GH recommends that additional information from CNBM regarding its activity of PV module production is provided	A
4	Technology		3.1.10	GL GH recommends to obtain: – Letter of acceptance for the specific plant design, issued by the PV module supplier; – Minimum requirements for the plant design, issued by the PV module supplier, and corresponding acceptance by the plant constructor;	A
5	Technology		3.1.12	GL GH recommends that additional information from HHI regarding its activity of PV module production is provided	A
6	Technology		3.1.15	GL GH recommends to obtain: – Letter of acceptance for the specific plant design, issued by the PV module supplier; – Minimum requirements for the plant design, issued by the PV module supplier, and corresponding acceptance by the plant constructor;	A
7	Technology		3.2.2	GL GH recommends requesting an acceptance letter from AEG specifically for these module types.	A
8	Technology		3.2.2	GL GH recommends the Client to request track records of field deployed units or independent review of the inverter to support claimed performance.	B
9	Construction	NSI	4.2	Three recommendations have been included in that section concerning the NSI contract. Refer to report for details.	B
10	Construction	Activ Solar Trading/Cables	4.4	The location of the delivery term should be Perovo in the cables supply contract.	C

Item	Subject	Contractor	Section	GL GH Recommendations	Critical level
11	Construction	Activ Solar Trading/Cables	4.4	GL GH recommends including the technical specification of the cables in the contract.	A
12	Construction	Activ Solar Trading/Structures	4.4	The location of the delivery term should be Perovo in the mounting system supply contract.	C
13	Construction	Activ Solar Trading/Structures	4.4	GL GH recommends including the technical specification of the mounting systems in the contract.	A
14	Construction	Activ Solar Trading/Main	4.5.1	GL GH recommends including the technical specification of the PV modules in the contract.	A
15	Construction	Activ Solar Trading/Main	4.5.1	GL GH strongly recommends including in the scope the independent analysis of a sample of each type of modules by an independent laboratory to control the products delivered.	A
16	Construction	Activ Solar Trading/Main	4.5.1	GL GH recommends including the technical specification of the AEG substation in the contract.	A
17	Construction	Activ Solar Trading/Main	4.5.1	GL GH recommends including the technical specification of the pyranometers in the contract.	A
18	Construction	Activ Solar Trading/Main	4.5.2	The custom import taxes are not part of the price. GL GH recommends including it in the contract.	C
19	Construction	Activ Solar Trading/Main	4.5.2	In schedule 1 of the contract a minimum volume of 20 MWp delivered should be indicated sine the price is fixed.	A
20	Construction	Activ Solar Trading/Main	4.5.2&5	There is no money kept for the completion to provide a security before the test have been passed. A minimum of 5-10% is recommended at the Provisional Acceptance Certification.	A
21	Construction	Activ Solar Trading/Main	4.5.3	The list of validation for the completion is not comprehensive based on the standard of the industry. See Appendix 14 for a typical example.	A
22	Construction	Activ Solar Trading/Main	4.5.3	GL GH recommends adding a punch list for the completion	A
23	Construction	Activ Solar Trading/Main	4.5.3	GL GH recommends detailing the different tests to be done during to validate the provisional Acceptance.	A
24	Construction/ O&M	Activ Solar Trading/GreenTech	4.5.4&4.7.1	GH recommends to provide a standard material warranty and to add the workmanship in case the O&M contract does not take it into account during the two first years. GL GH recommends also discussing with the legal advisor for the validity of this warranty.	A

Item	Subject	Contractor	Section	GL GH Recommendations	Critical level
25	Construction	Activ Solar Trading/Main	4.5.4	GL GH recommends including a proper performance ratio warranty.	A
26	Construction	Activ Solar Trading/Main	4.5.4	GL GH recommends amending the contract for the delays as follows: • The cap price should be set to a minimum of 10 %, and • The contractor should be responsible to prove that the penalty is not justified	A
27	Construction	Activ Solar Trading/Main	4.5.4	GL GH recommends including a 100% liability clause in case of a termination of the contract. • The cap price should be set to a minimum of 10 %, and • The contractor should be responsible to prove that the penalty is not justified	A
28	Construction	Activ Solar Trading/Main	4.5.5	GL GH recommends detailing the Final Acceptance.	A
29	Construction	Activ Solar Trading/Main	4.6	GL GH recommends including a Bank Guarantee for the advance payment and for the Final Acceptance.	A
30	Construction	Activ Solar Trading/Main	4.7	General recommendation for the contractual structure of the construction phase. Refer to report for details.	A
31	O&M	GreenTech	4.7.1	The security is better included in the O&M contract	C
32	O&M	GreenTech	4.7.1	The cleaning of the modules should be analysed based on the snow conditions in winter or the dust conditions in the summer.	C
33	O&M	GreenTech	4.7.1	The minor repairs should be part of the corrective maintenance	C
34	O&M	GreenTech	4.7.1&4.7.5	Several recommendations for the correction scope of work are detailed in the section. Refer to report for details.	A
35	O&M	GreenTech	4.7.2&4.7.5	The contract should start at the first energisation, for the O&M contractor to have training and witness the acceptance tests.	A
36	O&M	GreenTech	4.7.3&4.7.4&6.4	The price of the O&M contract is not disclosed in the contract. It should be done in accordance with the OPEX level in the financial model.	A
37	O&M	GreenTech	4.7.5	Several recommendations for the O&M contract are indicated in this section	A
38	O&M	GreenTech	4.7.5&6.4	The replacement of the modules, since it is not included in the O&M contract should be provisioned in the financial model or included in the initial stock plus the labour cost in the O&M contract price	A

Item	Subject	Contractor	Section	GL GH Recommendations	Critical level
39	Time Schedule		5	GL GH considers that the construction schedule should be updated to take into account the previous comments and correspond to the announced completion date.	B
40	Financial model		6.1	GL GH strongly recommends to review the annual energy used in the model.	A
41	Financial model		6.3&4.6	GL GH recommends enclosing a provision for contingencies in the financial agreement, thereby limiting the CAPEX engagement for the Lenders.	A
42	Financial model		7.4	GL GH recommends that the Insurance Advisor checks the insurance figure in the OPEX.	B

Table 1.4: GL GH recommendation table

2 INTRODUCTION

GL Garrad Hassan Ibérica (“GL GH”) has been contracted by VTB Capital (“the Client”) to undertake the Technical Due Diligence of the 80 MWp solar photovoltaic (PV) plant (“the Project”), to be constructed in the Peninsula of Crimea in Ukraine, close to Simferopol city. The Project is being developed by Activ Solar (“the Developer”), in four phases of 20 MWp each. These phases are called Alfa Solar, Beta Solar, Gamma Solar and Zeta Solar. The present report refers to the Alfa Solar phase, corresponding to a quarter of the total installed capacity of the project.

The main contents of this report are listed below:

- Technology review (PV module and inverter);
- Contract review (PV module supply contract, Balance of Plant contract and O&M contract);
- Time schedule review; and
- Technical inputs to the financial model.

The following contents for the entire project have been assessed in separate GL GH reports, [2.1] and [2.2]:

- Site layout review;
- High level design technical review; and
- Independent energy assessment.

The Jinko track records are provided in Appendix 1 and IEC certificates for the Jinko PV modules are included in Appendix 2. The CNBM PV modules technical datasheet is included in Appendix 3, the CNBM certificates are included in appendix 4 and the CNBM warranties are included in Appendix 5. Appendix 6 contains information about the Hyundai track records, appendix 7 provides the technical specification of the Hyundai PV modules, and appendix 9 shows the warranties of the Hyundai PV modules and appendix 10 the UL certificates of Huyndai. For the AEG inverters, the tracks records are provided in Appendix 11, the specifications are provided in Appendix 12 and the CE mark is provided in Appendix 13. Finally, the Appendix 14 is showing the typical list of expected documentation for a provisional acceptance and for a final acceptance.

The general location of the project can be seen in Figure 2.1. The detailed locations of each individual phase of the project can be seen in Figure 2.2.

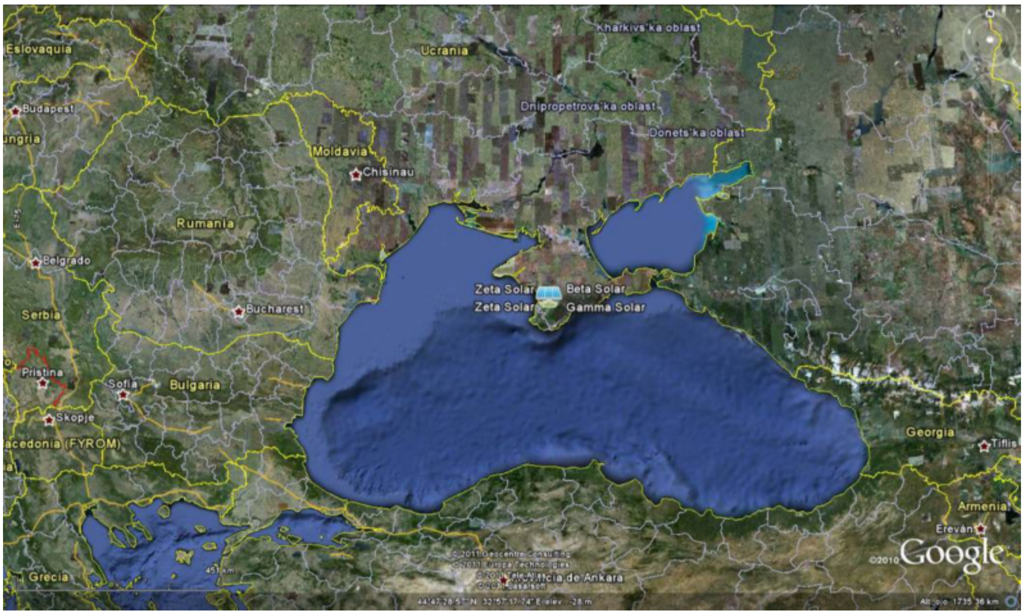


Figure 2.1: Location of the Alpha Solar PV Plant

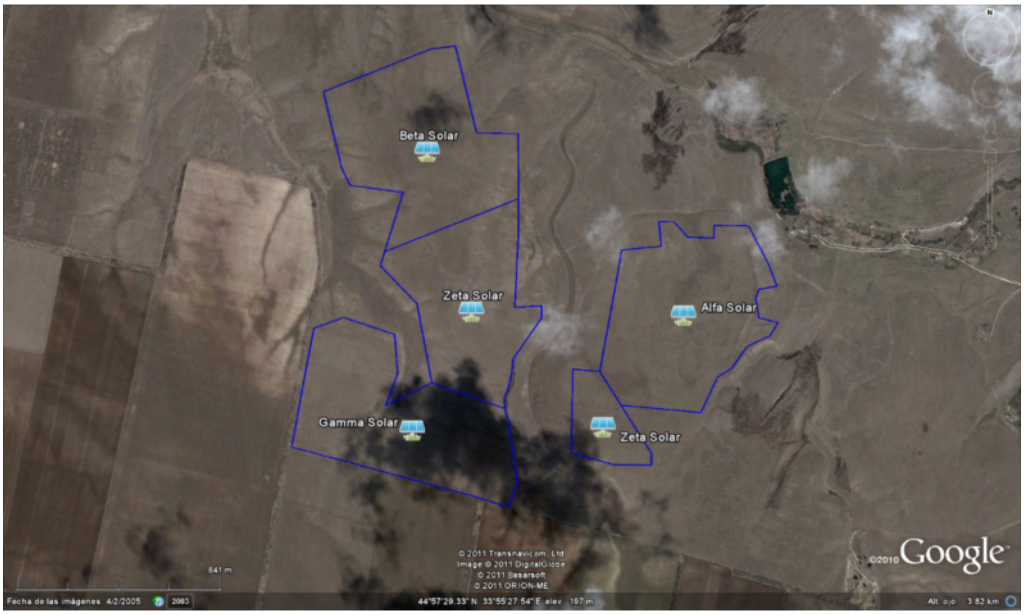


Figure 2.2: Bird's eye view of the site

3 TECHNICAL REVIEW OF THE PORTFOLIO PROPOSED TECHNOLOGY

GL GH has reviewed the proposed technology for the Project, focussing on the PV modules, the inverters and the manufacturers' capability.

3.1 PV Modules

The PV plants will consist of polycrystalline silicon technology. Three PV module manufacturers are considered in this review:

- Jinko Solar, Chinese manufacturer, module JKM225P-60, 225 Wp
- CNBM International Corp, Chinese manufacturer, module CNBM 230P, 230 Wp
- Hyundai Heavy Industries (HHI), Korean manufacturer, module HiS-M230MG (to be confirmed), 230 Wp.

3.1.1 Jinko Solar as a manufacturer and market situation

Jinko Solar is a recent arrival to the solar industry and was founded in January 2006 as a silicon waste processing company. The following year, the firm moved into the production of silicon ingot manufacturing. By the fall of 2008, Jinko Solar was producing 185 MW of solar wafers annually. In order to move into the production of solar cells and modules, in 2009, Jinko Solar acquired the firm Sun Valley, a cell and module producer located in China. With the exception of polysilicon production, the firm's goal of "vertical integration" is now complete. By September 2009, Jinko Solar had installed an automated production line for PV modules. By controlling in-house the production of silicon ingots, wafers, cells and modules through vertical integration of the manufacturing process, the company potentially has a greater opportunity to control the quality of the production process. Additionally, this kind of structure allows for greater cost control of these processes by avoiding sub-contracting this portion of the manufacturing process to outside firms. From this point onward, Jinko Solar has moved rapidly to expand its production capacity as well as its access to public finance markets. To that end, Jinko Solar was listed on the New York Stock Exchange in 2010 through an IPO. It has subsequently used the IPO proceeds as well as funds provided by its on-going operations to reach an annual production capacity of 600 MW of wafers, 300 MW of cells, and 450 MW of modules by the fall of 2010. This number has since expanded to pursue the goal of reaching an anticipated one GW annual production capacity by the end of 2011

Jinko Solar corporate facilities structure presently consists of the following:

- Two manufacturing facilities located in China; one in Jiangxi Province and one in Zhejiang Province
- Four sales and marketing offices, one located in Shanghai China, one in Munich Germany, one in Bologna Italy and one in San Francisco, CA USA,

Jinko Solar also maintains a European distribution center in Rotterdam. Jinko Solar's production capacity with regards to existing Chinese PV module manufacturers places it as one of the largest manufacturers of PV modules in China. Further with a total production capacity of over one GW expected by the end of 2011, Jinko will be placed among the largest PV module manufacturers in the world.

The list of references of large scale PV plants supplied with Jinko Solar modules has been provided to GL GH. Table 3.1 summarizes the list of representative projects with Jinko Solar panels installed. The projects total approximately 60 MWp across 22 projects.

Project Country	**Approx Power (kWp)**	**Project Bank**	**Number of projects**
Czech Republic	5 500	Raiffeisen, Volksbank	2
France	9 000	Natixis, Others	3
Germany	10 000	Berliner, Deutsche, others	6
Israel	6 000	Leumi, Poalim	2
Italy	29 500	Banca Popolare, BBC, Centrobanka, UniCredit,others	9
Total	**60 000**	**23**	**22**

Source: Jinko Solar June 2011 Presentation

Table 3.1: Jinko Solar References

Appendix 1 contains some examples of utility scale solar projects which utilize Jinko solar modules.

3.1.2 Origin of the Jinko Solar PV module manufacturing technology

GL GH has not been engaged to conduct a bankability report for Jinko Solar modules. Additionally, GL GH has not been provided with a 3rd party bankability report for Jinko Solar modules. As a result, the following analysis is based upon Jinko Solar provided materials, publicly available information, and GL GH experience in evaluating similar products from other PV module manufacturers. According to certification documentation provided by Jinko Solar, the silicon wafers and cells used in the company's PV modules are supplied by Jinko Solar itself, manufactured in one of two company plants located in China. As of September 2010, the firm had the following annual production capacity [3.1]:

- Silicon wafers: 600 MW
- Silicon cells: 300 MW
- PV modules: 450 MW

Jinko Solar has targeted 600 MW production capacities for each of the three components to be achieved by the end of 2011. This goal would be compatible with the firm's vertical integration business model in that it would achieve balance among all of its manufacturing lines.

It has not been independently verified by GL GH that Jinko Solar's wafers and cells are used exclusively in the manufacturing of Jinko Solar PV modules. However, due to the company's production capacity profile, it is unlikely that Jinko Solar needs to use other wafer or cell suppliers for its modules. Consequently, based upon company supplied and publicly available information, there is a high probability that Jinko Solar manufactures all of its own silicon wafers, cells, and modules.

Though it is considered that polycrystalline technology has an acceptable track record and operating history, GL GH recommends that the Sponsor confirms with Jinko Solar that:

- All the suppliers for project modules are the same than the one mentioned in the TüV Rheinland IEC 61215:2005 certificates, in particular the cell supplier. In that sense, the fully traceability of the components of each module would be necessary to check that. GL GH recommends confirming with Jink Solar the degree of traceability of the components; and
- All Jinko Solar PV modules follow exactly the same manufacturing process, in order to be comfortable that their performance and conformance to IEC standards will be consistent.

According to the reviewed documentation, Jinko Solar PV modules are following exactly the same manufacturing process irrespective of the factory that produces the modules, or the manufacturing line within each factory.

By procuring such information supporting the quality and the origin of the technology, GL GH would consider that the associated technical risk of using Jinko Solar technology remains small to moderate. If a positive Bankability report is provided then the risk would be small.

3.1.3 Certifications of Jinko Solar as manufacturer

Regarding quality and environmental management, Jinko Solar has secured the following Certifications as a PV manufacturer:

- The standard quality management ISO 9001:2008. This Certification represents that the organisation satisfies the customer’s quality requirements, whilst aiming to enhance customer satisfaction. This Certificate, Registration No. 442551 QM08, is valid until 11-12-2012; and
- The standard environmental management ISO 14001:2004. This certification entails that the organisation awarded is implementing, maintaining and improving an environmental management system, whilst ensuring compliance with environmental laws and regulations. This Certificate, Registration No. 442442 UM is valid until 18-04-2013.

Jinko Solar is a Full Compliant Member of the PV Cycle association, a voluntary program to ensure the recycling of the modules after their useful life has been reached. The PV Cycle association has currently 180 Full Compliant Members, 8 Full Members (i.e. in the process of meeting the requirements for being Full Compliant Members), and 25 Members Associate.

In conclusion, GL GH considers the ISO 9001 and ISO 14001 certification supports the control quality of the IEC certification. The problem with these certifications is that the number of units manufactured per year is extremely high (more than 2.5 million modules per year) compared to the number of modules inspected by third parties (less than one hundred). Therefore, the internal quality procedure checked independently as provided in a Bankability report of the technology is the only mitigation factor for the identified risk.

3.1.4 Jinko Solar PV module technical specifications

According to an Photon International market survey conducted in February 2011, where a total of 204 PV module manufacturers and more than 5,000 PV modules were reviewed, the average efficiency of polycrystalline modules has been increasing constantly, to an approximate value slightly above 14% in 2011.

This market survey underlines also that the polycrystalline silicon modules between 190 Wp and 240 Wp are dominating the market. Moreover, the module standard is made of 60 cells (156x156 mm cell dimensions) as for the JKM225P-60. It can be concluded that the JKM225P-60 module is marketed within a competitive rated power range.

Table 3.2 presents the relevant technical parameters concerning the PV module JKM225P-60 indicated in the technical datasheet provided by Jinko Solar. The electrical parameters and temperature coefficients are standard for a PV module of this type.

Jinko Solar JKM225P-60 PV MODULE	
Manufacturer	Jinko Solar
Model	JKM225P-60
Technology	Polycrystalline
Calculated module efficiency (%)	13.74
Rated power at STC (Wp)	225
Power tolerance (%)	+ 3 / - 3
MPPT voltage at STC (V)	29.4
MPPT current at STC (A)	7.65
Open circuit voltage at STC (V)	36.7
Short circuit current at STC (A)	8.25
T coefficient I_{sc} (%/°)	0.04
T coefficient V_{oc} (%/°)	-0.33
T coefficient P_{mppt} (%/°)	-0.48
NOCT	48ºC +/- 2ºC

Source: Jinko Solar

Table 3.2: Technical specification of the JKM225P-60

The Jinko Solar PV module power tolerance is +/- 3%. This range is typical of this type of PV module.

The technical specification for Jinko Solar PV module indicates a power temperature coefficient of -1,08mW/°C for the JKM225P-60 module. These coefficients are indicated as percentage of the rated power in Table 3.2.The results in percent are in the range of the market standard.

The physical construction of the Jinko Solar PV module follows typical industry standards of crystalline silicon technology:

a) Front cover: thermally pre-stressed 3.2 mm solar glass;

b) Encapsulation: EVA (Ethylene-vinyl acetate);
c) Back cover: TPT- (Tedlar-polyethylene terephthalate-Tedlar) composite film; and
d) Frame: extruded anodized aluminum (6063 T5).

In addition, Table 3.3 presents other characteristics of the Jinko Solar PV module remaining in the technical data sheet completed with information given in the TuV report for IEC 61730-1:2004 and IEC 61730-2:2004 Certification (see Section 3.1.9), GL GH notes that the characteristics are found to be the market standard for a crystalline silicon PV module of this type.

Jinko Solar JKM225P-60 PV MODULE	
Dimensions (l x w x h) [mm]	1650 x 992 x 45
Weight (kg)	19
Cell supplier	Jinko Solar
Cell type	Polycrystalline
Cell dimensions l x w [mm]	156 x 156
Number of cells	6 x 10
Bypass diodes supplier	Yangzhou Yangjie Electronic Co., Ltd.
Cells per bypass diode	10
No. of bypass diodes	6
Junction box supplier	CiXi Renhe
Connectors supplier	CiXi Renhe
Cables supplier	CiXi Renhe

Source: Jinko Solar and TüV report for IEC 61730-2 Certification

Table 3.3: Other characteristics of the Jinko Solar JKM225P-60 PV module

GL GH notes that the cell supplier for the PV modules used in the IEC certification is Jinko Solar. Therefore, if the PV cells finally supplied to the modules are not manufactured by Jinko Solar then the certificates will be not valid. GL GH strongly recommends to require the full traceability of the components of the modules from the manufacturer.

3.1.5 Certifications of Jinko Solar PV Modules

General information on the PV modules certifications

A good definition of Certification is provided by the IEC (International Electrotechnical Committee) and this is included below:

> "Certification is the procedure by which a third party gives written assurance that a product, process or service conforms to specified requirements".

The advantages of having certification are that:

- It avoids repeated investigation of the same thing;
- It provides a generally acceptable assessment of the product, without any additional cost to the buyer;
- It naturally includes evolution in design knowledge, because the codes are kept updated; and

– Industry practice relies on certification.

However, the certificate is not a warranty and does not address issues that do not affect the product's structural integrity. For this reason, track record and experience with the specific product are still necessary to provide comfort to the buyer, even if the product has been certified. In this sense, some criticism of the typical certificates for PV modules is provided further on in this section.

There are four main types of standards that are applicable to PV modules:

a) Safety requirements:

The relevant standards concerning module safety are: UL 1703 (applicable mainly in the USA - UL means Underwriters Laboratory), Safety Class and IEC 61730.

The IEC 61730 combines European Safety Class II and UL 1703. It has been applicable since 2004 and is not applicable to PV modules with integrated inverters. Tests of this standard can be co-ordinated with the corresponding tests of the IEC 61215 (commented on further below), in order to avoid repetition of tests. A short description of the IEC 61730 standard, Photovoltaic (PV) module safety qualification is given below:

Part 1: Requirements for construction.

This part of IEC 61730 describes the fundamental construction requirements for photovoltaic (PV) modules, in order to provide safe electrical and mechanical operation during their expected lifetime. Specific topics are provided, in order to assess the ability to prevent electrical shock, fire hazards and personal injury, due to mechanical and environmental stresses. This part of IEC 61730 pertains to the particular requirements of construction. IEC 61730-2 outlines the requirements of testing.

The objective of Part 1 is to provide basic guidance in certifying the fundamental construction of photovoltaic modules presented for safety approval, through testing under IEC 61730-2. These requirements are intended to minimise the misapplication and misuse of modules, or the breakdown of internal components, which would result in fire, electric shock and personal injury. The standard defines the basic safety requirements for construction, and additional tests that are a function of the module end-use applications.

Component requirements are intended to provide evidence of the performance of a component, appropriate to its application in the module construction and environment.

Part 2: Requirements for testing.

This part of IEC 61730 describes the testing requirements for photovoltaic (PV) modules, in order to provide safe electrical and mechanical operation during their expected lifetime. Specific topics are provided, to assess the prevention of electrical shock, fire hazards and personal injury, due to mechanical and environmental stresses. IEC 61730-1 pertains to the particular requirements for construction. This part of IEC 61730 outlines the requirements for testing.

The objective of Part 2 is to provide a testing sequence intended to verify the safety of PV modules, whose construction has been assessed by IEC 61730-1. The test sequence and pass criteria are designed to detect the potential breakdown of internal and external components of PV modules, which would result in fire, electric shock and personal injury. The standard defines the basic safety test requirements and additional tests that are a function of the module end-use applications.

Test categories include general inspection, electrical shock hazard, fire hazard, mechanical stress, and environmental stress.

The Safety Class II (SKL II) applies for voltage operation above 120 V. By using safety class II materials in the PV module and its components (junction box, wires and live parts) the overall module offers protective insulation for persons. This protection should be sustained during the operating life of the equipment. These tests comprise a visual inspection and some specific electrical tests.

b) Performance:

The relevant standards concerning module performance are: IEC 61853, ASTM E1036, FSEC 201-05, and FSEC 202-05 (FSEC means Florida Solar Energy Center, and ASTM means American Standard for Testing Materials). The most relevant standard regarding the performance of the module is IEC 61853: Power and energy rating of photovoltaic (PV) modules. Part 1 refers to the power rating, Part 2 refers to testing methods, Part 3 refers to the energy rating and Part 4 refers to the standard days.

The aim of IEC 61853 is to define tests to be carried out, in order to provide a complete set of optical, thermal and electrical parameters that fulfil the requirements for an accurate simulation of the PV module. In development since 1995, the edition 1 of the part I: *Irradiance and temperature performance measurements and power rating* of the standard IEC 61853 has been approved for publication in January 2011.

This standard is helpful for designers, developers and engineers and it is expected that most PV manufacturers will provide the corresponding certificates.

c) Reliability and durability:

The standard applicable to crystalline silicon technologies is IEC 61215: Crystalline silicon terrestrial photovoltaic (PV) modules – design qualification and type approval. This standard sets out requirements for the design qualification and type approval of terrestrial photovoltaic modules that are suitable for long-term operation in general open-air climates. It also determines the electrical and thermal characteristics of the module and shows (as far as possible) that the module is capable of withstanding prolonged exposure in certain climates.

The first edition of the IEC 61215 appeared in 1993 and the second edition in 2005. The main differences between Ed. 1 and Ed. 2 are related to the thermal cycle and Ultra Violet (UV) tests. Moreover, the twisting test of the module has been removed in Ed. 2 and the diode test has been added.

As indicated above, there are some grounds for criticism regarding the representativeness of the IEC 61215 certificates to the real outdoor conditions for PV modules:

- The Certification is based on tests applied in parallel with a sample of 8 PV modules, in order to save time. The number of PV modules is clearly not representative of the total amount of PV modules manufactured by Jinko Solar every year. On the other hand, the real outdoor conditions experienced by the PV modules may certainly be additive, compared with the parallel tests applied.

- The tests to simulate the ambient conditions of PV modules are not well defined for representing the real outdoor conditions. In particular, the endurance test is defined at a force and vacuum of 2,400 Pa, for a period of one hour. Some manufacturers state that this corresponds to a wind speed of 130 km/h, which is not necessarily the case. The IEC testing conditions cannot perfectly reproduce the force of a real storm. Even if a PV module can resist high winds, the fixing settings, which are not part of the PV module, are the weak point of resistance, due (typically) to poor installation. There are some recent examples of PV modules resisting winds of 185 km/h, but not of the fixing system to the supporting structure resisting the same.

- The accelerated life tests for IEC standards have been shown to underestimate some issues arising in outdoor exposure. One such issue is ultraviolet irradiation, which is tested for a total of 15 kWh/m², when the modules will probably receive more than 1,000 kWh/m² over 20 years. Therefore, the track record of the manufacturer is still important, in order to have confidence in the durability of the module.

- The Certification does not consider specific climatic conditions, such as the extremely cold weather of northern territories or the tropical weather of the Caribbean.

The above criticism may be mitigated by the following facts:

- Quality control of the manufacturing process (above the minimum level required by the standards) via periodic factory inspections.
- Operating history. Manufacturers of PV modules that have been in the market for a relatively short period of time (less than 10 years), therefore they should provide information on the historic performance. However, accumulated experience with crystalline silicon technology amounts to more than 30 years.

d) CE mark:

The statement regarding the CE mark should include the list of standards and EC Directives required for obtaining it. This mark is mandatory for the sale of many products within the European Union.

Jinko Solar PV modules certifications

The PV module data sheet, provided by Jinko Solar, states that their PV modules presents certificates IEC 61215 and 61730 (Parts 1&2), and the CE mark. To support this information, the IEC 61215:2005 and EN 61730-1:2007/EN 61730-2:2007 certificates have been provided, issued by TüV in July and August of 2010 respectively, as well as Jinko Solar Declaration of conformity with the CE mark requirements as defined by EN 61000-6-1:2007/EN 61000-6-3:2007 issued by SGS. These documents are attached in Appendix 2. The test reports referring to IEC 61215 and 61730 have been provided.

From the PV module data sheet, GL GH can confirm that Jinko Solar does not hold an IEC 61853, regarding the performance of the module. In addition, in the module data sheet provided by Jinko

Solar and in the EN 61730 Test Report, it is stated that a PV module fulfils the requirements of Safety Class II, that it can be used in PV plants at a maximum system voltage (Voc at STC) of 1,000 V (Direct Current or DC) and that the PV module presents a Class C on the Fire Rating.

With respect to the mitigation factors of the previous discussion about the standards IEC 61215, GL GH notes that:

- Quality control of the manufacturing: ***No specific information on the internal quality control of Jinko Solar has been provided.***
- Operating history: Jinko Solar PV modules have been in the market for a short period of time (2 years). ***GL GH has no access to information regarding the historic performance of Jinko Solar PV modules, this should be provided if available.***

Finally, good operation of a PV plant depends on the suitability of the PV module to the selected plant design (strings, inverters, DC cables, etc). This is partially to be reviewed in separated reports ([2.1] and [2.2]). However, it is important to involve the PV module supplier in the plant design, in order to avoid warranty litigations due to a design not being accepted by the PV module supplier. In general terms, this risk would typically be mitigated by the following:

- Letter of acceptance for the specific plant design, issued by the PV module supplier;
- Minimum requirements for the plant design, issued by the PV module supplier, and corresponding acceptance by the plant constructor; and
- Inverter manufacturer acceptance of the selected PV module and plant design.

Power Degradation and Warranties

The PV module output may decrease over time. This performance degradation is the result of several factors:

a) Degradation of module "packaging" materials, such as glass breakage and "browning" of the ethylene vinyl acetate (EVA) encapsulant between the glass and the solar cells, due to UV exposure;

b) Loss of adhesion, causing delamination - mainly between the glass and encapsulant, or the encapsulant and the solar cells - and eventually leading to cell overheating;

c) Interconnect degradation of the welded joints, due to thermo mechanical fatigue;

d) Moisture intrusion through the module backsheet, or through the edges of modules, causing contact corrosion and increased electrical resistance; and

e) Semiconductor device degradation, especially with amorphous silicon modules - rare in crystalline silicon modules. The initial degradation is very high, but after a period of weeks or months it becomes stable.

Error! Reference source not found. Figure 3.1 shows the typical arrangement of material in a silicon PV module.

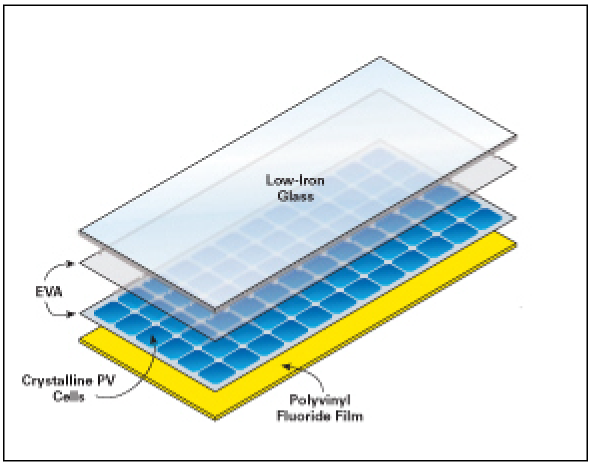


Figure 3.1: Typical material arrangement in a silicon PV module

The degradation mechanisms related to module packaging can be summarised, as follows:

- The module encapsulant protects the cells and internal electrical connections against moisture ingress. Because it is impossible to seal out moisture completely, modules actually "breathe" to a very small degree. Moisture that enters a module is forced back out on a daily basis, as module temperature increases. Because modules spend their lives out in the elements, sunlight slowly breaks down the encapsulation materials through ultraviolet (UV) degradation; they become less elastic and more plastic. Over time, this limits a module's ability to force out moisture. The trapped moisture eventually leads to corrosion around the cell's electrical connections, resulting in higher resistance at the affected connections and (ultimately) decreased module operating voltage; and
- Obscuring of the EVA layer between a module's front glass and the silicon cells (caused by UV light) can limit the amount of sunlight hitting the cell over time. The result is a slight, but incremental, decrease in cell output.

Jinko Solar warrants a minimum performance of 90% of the nominal power during the first 12 years, whilst 80% of the nominal power output is warranted during the period running from year 11 to year 25 of the plant operation. Moreover, the financial model provided by the Sponsor [3.2] estimates an average yearly power degradation of 0.7% (see section 6.1). ***This figure should be supported with monitored plants or measurements.***

In addition, Jinko Solar gives a warranty for their modules of 5 years, which is pretty much standard in the market. ***Nevertheless, the warranty terms and conditions should be provided by Jinko Solar.***

3.1.6 CNBM as a manufacturer and market situation

CNBM (China National Building Material) International is a large, diversified China based manufacturer of building materials. The firm was incorporated in 1984 and is now made up of over 300 facilities which produce a wide variety of building materials and structures for both domestic use as well as export. Within the CNBM International group lays CNBM Solar, whose primary function appears to be the manufacture, marketing and distributing PV modules.

From supplied documentation and publicly available information sources, it is not clear if CNBM Solar actually produces all of its crystalline silicon solar modules. CNBM appears to have contracted in the past with existing manufacturers of PV modules and then "brand" the modules as CNBM. That said, contained in one piece of CNBM International marketing material, the company states that it entered the solar PV industry in 2005 and that it posses an annual production capacity of 220 MW. It does not stipulate if this production capacity is for wafers, cells, modules, or any combination thereof. As a result GL GH is unable to comment in detail about CNBM as a PV module manufacturer. ***CNBM should provide the identification of exactly what PV module manufacturing firm or firms are to provide the modules to the Project.*** Unless and until this information is provided, there is risk associated with utilizing this PV module.

3.1.7 Origin of CNBM PV module technology

GL GH has not been engaged to conduct a bankability report for CNBM Solar modules. Additionally, GL GH has not been provided with a 3rd party bankability report for CNBM Solar modules. As a result, the following analysis is based upon CNBM Solar provided materials, publicly available information, and GL GH experience in evaluating similar products from other PV module manufacturers.

For the project that is the subject of this report, it can be determined that CNBM PV modules will utilize polycrystalline technology. As GL GH does not have access to additional detailed information, we are unable to provide additional comment. However, as the module design appears to follow standard industry practices, it is probable that the module has similar performance as the other panels identified in this report. Please reference section 3.1.9 below for additional related information.

Though it is considered that polycrystalline technology has an acceptable track record and operating history, GL GH recommends that the Sponsor confirms with CNBM Solar that:

- CNBM is in fact the manufacturer and supplier of all project modules are the same model numbers as are referenced in the TUV Rheinland IEC 61215:2005 certificates. In that sense, the fully traceability of the components of each module would be necessary to check that. GL GH recommends confirming with CNBM Solar the degree of traceability of the components; and
- All CNBM PV modules follow exactly the same manufacturing process, in order to be comfortable that their performance and conformance to IEC standards will be consistent.

By procuring such information supporting the quality and the origin of the technology, GL GH would consider that there is a moderate level of technical risk of using CNBM Solar technology.

3.1.8 Certification of CNBM Solar as a manufacturer

Regarding quality and environmental management, CNBM International has secured the following Certification as a *general* manufacturer:

- The standard quality management ISO 9001:2008. This Certification represents that the organisation satisfies the customer's quality requirements, whilst aiming to enhance customer satisfaction. This Certificate, SGS Registration No. CN10/10218 is valid until 13-05-2013.

It should be noted that this certification is for, among other activities, "…new energy products…" CNBM should be consulted to determine if this general statement applies to CNBM brand solar modules.

- At the time of this writing, the standard environmental management ISO 14001:2004 has not been provided. This certification entails that the organisation awarded is implementing, maintaining and improving an environmental management system, whilst ensuring compliance with environmental laws and regulations.

CNBM is not a member of the PV Cycle association, a voluntary program to ensure the recycling of the modules after their useful life has been reached. The PV Cycle association has currently 180 Full Compliant Members, 8 Full Members (i.e. in the process of meeting the requirements for being Full Compliant Members), and 25 Members Associate.

In conclusion, GL GH cannot make a determination if the CNBM International's ISO 9001 certification supports the control quality of the IEC certification of CNBM solar modules. Until such question is answered, there is risk associated with the manufacturing and management control certification of CNBM PV modules. The problem with these certifications is that the number of units manufactured per year is extremely high (almost 1 million modules per year) compared to the number of modules inspected by third parties (less than one hundred). Therefore, the internal quality procedure checked independently as provided in a Bankability report of the technology is the only mitigation factor for the identified risk.

3.1.9 CNBM Solar PV module technical specifications

The CNBM solar PV module part number CNBM 230P will be used in the project.

Table 3.4 presents the relevant technical parameters concerning the PV module CNBM 230P as indicated in the technical datasheet provided by CNBM Solar, which can be found in Appendix 3. The electrical parameters and temperature coefficients are standard for a PV module of this type.

CNBM Solar CNBM 230P PV MODULE	
Manufacturer	CNBM Solar
Model	CNBM 230P
Technology	Polycrystalline
Calculated module efficiency (%)	14
Rated power at STC (Wp)	230
Power tolerance (%)	+ 3 / - 3
MPPT voltage at STC (V)	30.4
MPPT current at STC (A)	7.66
Open circuit voltage at STC (V)	37
Short circuit current at STC (A)	8.18
T coefficient I_{sc} (%/°)	0.05
T coefficient V_{oc} (%/°)	-0.35
T coefficient P_{mppt} (%/°)	-0.45
NOCT	47ºC +/- 2ºC

Source: CNBM Solar

Table 3.4: Technical specification of the CNBM 230P

The CNBM Solar PV module power tolerance is +/- 3%. This range is typical of this type of PV module.

The technical specification for CNBM Solar PV module indicates a power temperature coefficient of -1,04mW/°C for the CNBM 230P module. These coefficients are indicated as percentage of the rated power in Table 3.4. The results in percent are in the range of the market standard.

The physical construction of the CNBM Solar PV module follows typical industry standards of crystalline silicon technology:

- Front cover: thermally pre-stressed solar glass;
- Encapsulation: EVA (Ethylene-vinyl acetate);
- Back cover: TPT- (Tedlar-polyethylene terephthalate-Tedlar) composite film; and
- Frame: extruded anodized aluminum.

In addition, Table 3.5 presents other characteristics of the CNBM Solar PV module remaining in the technical data sheet. GL GH notes that the known characteristics are found to be the market standard for a crystalline silicon PV module of this type.

CNBM Solar CNBM 230PPV MODULE	
Dimensions (l x w x h) [mm]	1650 x 992 x 46
Weight (kg)	21
Cell supplier	Unknown
Cell type	Polycrystalline
Cell dimensions l x w [mm]	156 x 156
Number of cells	6 x 10
Bypass diodes supplier	Unknown
Cells per bypass diode	Unknown
No. of bypass diodes	Unknown
Junction box supplier	Unknown
Connectors supplier	Unknown
Cables supplier	Unknown

Source: CNBM Solar

Table 3.5: Other characteristics of the CNBM 230P PV module

As GL GH does not have complete IEC certification report documentation, further detail regarding the content of Table 3.5is unavailable. GL GH strongly recommends to require the fully traceability of the components of the PV module from the manufacturer. Component suppliers not recognized in the corresponding certificates should not be accepted.

3.1.10 Certifications of the PV modules

CNBM Solar PV modules certifications

The PV module data sheet, provided by CNBM Solar, states that their PV modules present certificates IEC 61215 and 61730 (Parts 1&2), and the CE mark. To support this information, the IEC 61215:2005 and EN 61730-1:2007/EN 61730-2:2007 certificates have been provided, both issued by TüV in December 2010, as well as Attestation of Conformity with the CE mark requirements issued by TüV in June 2011. These documents are attached in Appendix 4. The test reports referring to IEC 61215 and 61730 have not been provided. ***These documents should be requested by Client.***

From the PV module data sheet, GL GH can confirm that CNBM Solar does not hold an IEC 61853, regarding the performance of the module. In addition, in the module data sheet provided by CNBM Solar and in the EN 61730 Test Report, it is stated that a PV module can be used in PV plants at a maximum system voltage (Voc at STC) of 1,000 V (Direct Current or DC) and that the PV module presents a Class A on the Fire Rating.

With respect to the mitigation factors of the previous discussion about the standards IEC 61215, GL GH notes that:

- Quality control of the manufacturing: ***No specific information on the internal quality control of CNBM Solar has been provided.***
- Operating history. CNBM Solar PV modules have been in the market for a short period of time (5 years). ***GL GH has no access to information regarding the historic performance of CNBM Solar PV modules, this should be provided if available.***

Finally, good operation of a PV plant depends on the suitability of the PV module to the selected plant design (strings, inverters, DC cables, etc). This is to be reviewed in further sections. However, it is important to involve the PV module supplier in plant design, in order to avoid warranty litigations due to a design not being accepted by the PV module supplier. However, in general terms, this risk would typically be mitigated by the following:

- Letter of acceptance for the specific plant design, issued by the PV module supplier;
- Minimum requirements for the plant design, issued by the PV module supplier, and corresponding acceptance by the plant constructor; and
- Inverter manufacturer acceptance of the selected PV module and plant design.

CNBM Solar warrants a minimum performance of 90% of the nominal power during the first 10 years, whilst 80% of the nominal power output is warranted during the period running from year 11 to year 25 of the plant operation. Moreover, the financial model provided by the Sponsor [3.2] estimates an average yearly power degradation of 0.7% (see section 6.1). ***This figure should be supported with monitored plants or measurements.***

In addition, CNBM Solar gives a warranty for their modules of 5 years, which is pretty much standard in the market. Warranty terms and conditions are provided by CNBM Solar in Appendix 5.

3.1.11 Hyundai as a manufacturer and market situation

Hyundai Heavy Industries (HHI) is a large Korean heavy manufacturing company. Founded in 1972 as a shipbuilding concern, the firm consists of seven divisions; offshore & engineering, shipbuilding, industrial plants & engineering, electro & electronic systems, construction equipment, engines and machinery. Expected 2011 sales totals $26.6B USD. HHI employs approximately 24,400 individuals. HHI's involvement with PV module production dates from May 2008, when it built a factory to initiate cell and module production which at the time amounted to 30 MW. Subsequent investments occurred in 2009 and 2010 in plant located in Eumseong, Korea. These investments included additional value chain components including silicon ingot growers. Annual capacity in 2010 stood at approximately 270 MW at the module level. The existence of this business activity was formally recognized by HHI in January 2011, when the company formed its Green Energy Division to provide equipment to the wind, solar and tidal energy sectors on a global basis.

HHI is not able to support this production entirely with in-house produced wafers and cells. Consequently, it procures wafers from a number of established wafer manufacturers, including Silfab SpA of Italy with whom it has a wafer supply agreement out to 2015, LDK of China, as well as from other Korean and Taiwanese companies.

HHI has also made an investment in Korean chemical company KKC Corp. which will be used for the construction of a new polysilicon plant. HHI access to this production may amount to approximately 2400 tons annually. Nevertheless, this represents HHI's desire to control the entire solar value chain from polysilicon production to final module production in order to become at least partially totally vertically integrated.

Some project references that utilize HHI PV modules are identified in Appendix 6.

Note that HHI is a recent entrant into the solar industry, and in its current form, was formed only in January 2011. Consequently, information and operating history of the Green Energy Division is not readily available.

3.1.12 Origin if HHI Solar PV module manufacturing technology

GL GH has not been engaged to conduct a bankability report for HHI Solar modules. Additionally, GL GH has not been provided with a 3rd party bankability report for HHI Solar modules. As a result, the following analysis is based upon HHI Solar provided materials, publicly available information, and GL GH experience in evaluating similar products from other PV module manufacturers.

According to Photon International (2008-08-08), Hyundai has procured at least five, 50 MW fully automated production lines from various established suppliers of such equipment such as Roth & Rau AG and Centrotherm Photovoltaics AG. These contracts suggest that HHI wishes to become a supplier of mainstream PV modules so that it can supply its products on a global scale under accepted quality standards.

Based upon the limited amount of available data, the technology type (polycrystalline silicon) utilized in the construction of HHI PV modules follows industry standards. The purchase of industry accepted manufacturing equipment described above by HHI suggests that the company does not wish to deviate from industry standard manufacturing technologies. Rather, it intends to become a mainstream producer of PV modules, following a vertical integration business model similar to Jinko Solar, reviewed above.

Though it is considered that polycrystalline technology has an acceptable track record and operating history, GL GH recommends that the Sponsor confirms with HHI Solar that:

- HHI is in fact the manufacturer and supplier of all project modules are the same model numbers as are referenced in the TUV Rheinland IEC 61215:2005 certificates. In that sense, the fully traceability of the components of each module would be necessary to check that. GL GH recommends confirming with CNBM Solar the degree of traceability of the components; and
- All HHI PV modules follow exactly the same manufacturing process, in order to be comfortable that their performance and conformance to IEC standards will be consistent.

By procuring such information supporting the quality and the origin of the technology, GL GH would consider that the associated technical risk of using HHI Solar technology to be moderate.

3.1.13 Certifications of HHI Solar as manufacturer

Regarding quality and environmental management, HHI has secured the following Certifications as a PV manufacturer:

- The standard quality management ISO 9001:2008. This Certification represents that the organisation satisfies the customer’s quality requirements, whilst aiming to enhance customer satisfaction. This Certificate, No. 56656-7-2009-AQ-KOR-RvA, is valid until 23-02-2013. It should be noted that this Certificate specifically identifies the HHI facility where HHI designs, manufactures, tests and services PV modules and HHI inverters.
- The standard environmental management ISO 14001:2004 has not been provided. This certification entails that the organisation awarded is implementing, maintaining and improving an environmental management system, whilst ensuring compliance with environmental laws and regulations.

HHI Solar is a Full Compliant Member of the PV Cycle association, a voluntary program to ensure the recycling of the modules after their useful life has been reached. The PV Cycle association has currently 180 Full Compliant Members, 8 Full Members (i.e. in the process of meeting the requirements for being Full Compliant Members), and 25 Members Associate.

In conclusion, GL GH considers the ISO 9001 certification supports the control quality of the IEC certification. The problem with these certifications is that the number of units manufactured per year is extremely high (more than 1.1 million modules per year) compared to the number of modules inspected by third parties (less than one hundred). Therefore, the internal quality procedure checked independently as provided in a Bankability report of the technology is the only mitigant for the identified risk.

3.1.14 HHI Solar PV module technical specifications

The HHI Solar PV module part numbers to be used for the project have not been specifically provided. However, from the Enerparc AG energy Production report, it can be inferred that the MG series of HHI modules are to be used, specifically the HiS-M230MG due to its power, power tolerance of +3%/-0%, and 60 cell construction. This polycrystalline module is rated at 230 Wp. However, ***the specific part number to be deployed in the project should be confirmed.***

Table 3.6presents the relevant technical parameters concerning the PV module HiS-M230MG as indicated in the technical datasheet provided by HHI Solar, which can be found in Appendix 7. The electrical parameters and temperature coefficients are standard for a PV module of this type.

HHI HiS-M230MG PV MODULE	
Manufacturer	HHI
Model	HiS-M230MG
Technology	Polycrystalline
Calculated module efficiency (%)	14.2
Rated power at STC (Wp)	230
Power tolerance (%)	+ 3 / - 0
MPPT voltage at STC (V)	30.1
MPPT current at STC (A)	7.7
Open circuit voltage at STC (V)	37.1
Short circuit current at STC (A)	8.2
T coefficient I_{sc} (%/°)	0.056
T coefficient V_{oc} (%/°)	-0.32
T coefficient P_{mppt} (%/°)	-0.43
NOCT	46ºC +/- 2ºC

Source: HHI

Table 3.6:Technical specification of the HHI HiS-M230MG

The HHI Solar PV module power tolerance is +3% and -0%. This range is better than that of a typical PV module of this type.

The technical specification for HHI Solar PV module indicates a power temperature coefficient of -0,98mW/°C for the HHI HiS-M230MG module. These coefficients are indicated as percentage of the rated power in Table 3.4. The results in percent are in the range of the market standard.

The physical construction of the HHI Solar PV module follows typical industry standards of crystalline silicon technology:

- Front cover: thermally pre-stressed 3.2mm solar glass;
- Encapsulation: EVA (Ethylene-vinyl acetate);
- Back cover: TPT- (Tedlar-polyethylene terephthalate-Tedlar) composite film; and
- Frame: extruded anodized aluminum.

In addition, Table 3.7: Other characteristics of the HHI Solar HiS-M230MG PV module presents other characteristics of the HHI Solar PV module remaining in the technical data sheet. GL GH notes that the known characteristics are found to be the market standard for a crystalline silicon PV module of this type.

HHI Solar HiS-M230MG PV MODULE	
Dimensions (l x w x h) [mm]	1645 x 983 x 35
Weight (kg)	19
Cell supplier	HHI and various suppliers
Cell type	Polycrystalline
Cell dimensions l x w [mm]	156 x 156
Number of cells	6 x 10
Bypass diodes supplier	Unknown
Cells per bypass diode	20
No. of bypass diodes	3
Junction box supplier	Unknown
Connectors supplier	Unknown
Cables supplier	Unknown

Table 3.7: Other characteristics of the HHI Solar HiS-M230MG PV module

As GL GH does not have complete IEC certification report documentation, further detail regarding the content of Table 3.6 is unavailable. ***These documents should be provided.***

GL GH strongly recommends requiring fully traceability of the PV module component suppliers from the manufacturer.

3.1.15 Certifications of HHI Solar PV modules

The PV module data sheet, provided by HHI Solar, states that their PV modules possess certificates IEC 61215 (Ed. 2) and 61730 (Parts 1&2), CE mark, and is UL 1703 listed. To support this declaration, the IEC 61215:2005 and EN 61730-1:2007/EN 61730-2:2007 certificates have been provided by TüV Rheinland, both issued in October 2010, as well as HHI Certificate of Conformity with the CE mark requirements issued by TüV Rheinland in December 2010. The UL listing was achieved on or before April 2011. These documents are attached in Appendix 8 and 10. The test reports referring to IEC 61215 and 61730 have not been provided.

Two other certificates are also applicable to the HHI PV modules. Certification to standard 2PIG 1917/05.11, “Ammonia corrosion testing of photovoltaic (PV) modules”, and Statement of Conformity according to draft standard IEC 61701: 2nd Edition. The former standard tests the modules for resistance to ammonia rich environments, which may be present in and around farm structures upon which the modules may be mounted, especially where farm animals are housed, such as barns. The latter standard applies a salt mist corrosion test in order to determine the modules resistance to salt laden moisture induced corrosion. Such environments may exist in costal sea and ocean regions where the modules may be installed. While the project sites do not involve these two environmental conditions, these certificates do offer an additional level of comfort regarding the robustness of the module’s design.

From the PV module data sheet, GL GH can confirm that HHI Solar does not hold an IEC 61853, regarding the performance of the module. In addition, in the module data sheet provided by HHI Solar, it is stated that a PV module fulfils the requirements of Safety Class II which is part of IEC 61730; that it can be used in PV plants at a maximum system voltage (Voc at STC) of 1,000 V (Direct Current or DC) and that the PV module also conforms to Class C on the Fire Rating from UL.

With respect to the mitigation factors of the previous discussion about the standards IEC 61215, GL GH notes that:

- Quality control of the manufacturing: ***No specific information on the internal quality control of HHI Solar has been provided.***
- Operating history: HHI Solar PV modules have been in the market for a short period of time (2.5 years). ***GL GH has no access to information regarding the historic performance of HHI Solar PV modules, this should be provided if available.***

Finally, good operation of a PV plant depends on the suitability of the PV module to the selected plant design (strings, inverters, DC cables, etc). This is to be reviewed in further sections. However, it is important to involve the PV module supplier in plant design, in order to avoid warranty litigations due to a design not being accepted by the PV module supplier. However, in general terms, this risk would typically be mitigated by the following:

- Letter of acceptance for the specific plant design, issued by the PV module supplier;
- Minimum requirements for the plant design, issued by the PV module supplier, and corresponding acceptance by the plant constructor; and
- Inverter manufacturer acceptance of the selected PV module and plant design.

HHI Solar warrants a minimum performance of 90% of the nominal power during the first 10 years, whilst 80% of the nominal power output is warranted during the period running from year 11 to year 25 of the plant operation. Moreover, the financial model provided by the Sponsor [3.2] estimates an average yearly degradation of 0.7% (see section 6.1). ***This figure should be supported with monitored plants or measurements.***

In addition, HHI Solar gives a warranty for their modules of 5 years, which is pretty much the market standard. The standard warranty provided by HHI is located in Appendix 9

3.2 Inverters

The Alpha and Zeta PV plants are to incorporate inverters supplied by AEG Power Solutions. These SPVs are the only one within the Project for which GL GH was provided with the design, therefore the inverters type. GL GH understands that the inverter provider is the same for the 4 SPVs. The supplier overview is presented in the following sections.

3.2.1 General information

One of the critical parts of the Balance of Plant (BoP) in a PV plant is the inverter. Inverters are the power electronic devices that are directly connected to the PV array (on the DC side) and to the electrical grid (on the AC side). They essentially convert the DC energy produced by the array into AC energy required by the grid. In addition to high efficiencies for DC–AC conversion, and maximum power point tracking, inverters should produce AC energy of the required quality – with low total harmonic distortion of current, a high power factor (close to unity) and a low level of electromagnetic interference – to maximise the transfer of energy from the array to the grid. Inverters must also comply with safety requirements for users, equipment and the grid itself. The main characteristics that inverters must fulfil, and the testing procedures that they must comply with, are covered by the international standards IEEE 929-2000, EN 61727 and UL 1741.1–3. In April 2010, the IEC 62109-1 ed1.0 “Safety of power converters for use in photovoltaic power systems - Part 1: General requirements” has been published. The other relevant standard for grid-connected systems is IEC 60364-7-712 and there are further guidelines and requirements applied in different countries.

The inverter must perform a wide variety of functions:

1) For Maximum Power Point Tracking (MPPT), the system uses a control algorithm to keep the PV modules operating close to their peak power point, while the incoming solar radiation level varies.

2) Change the incoming DC received from the PV modules into AC, with suitable power quality. For grid-connected applications, the wave form needs to be close to a sine wave, i.e. with a low total harmonic distortion.

3) The inverter also has the function of separating electric circuits, and of disconnection from the grid to comply with safety requirements.

4) Inverters normally offer status reporting and monitoring.

PV inverter technology has evolved rapidly over the past decade, in line with general development in the PV sector - especially in Europe, the US and Japan. To reduce the cost-to-efficiency ratio, new inverter designs have appeared on the market, as shown in Figure 3.2. A general classification of inverter types is, as follows:

- Central inverters (the selected option for this plant);
- String inverters;
- Module integrated inverters (AC modules); and
- Multi-string inverters.

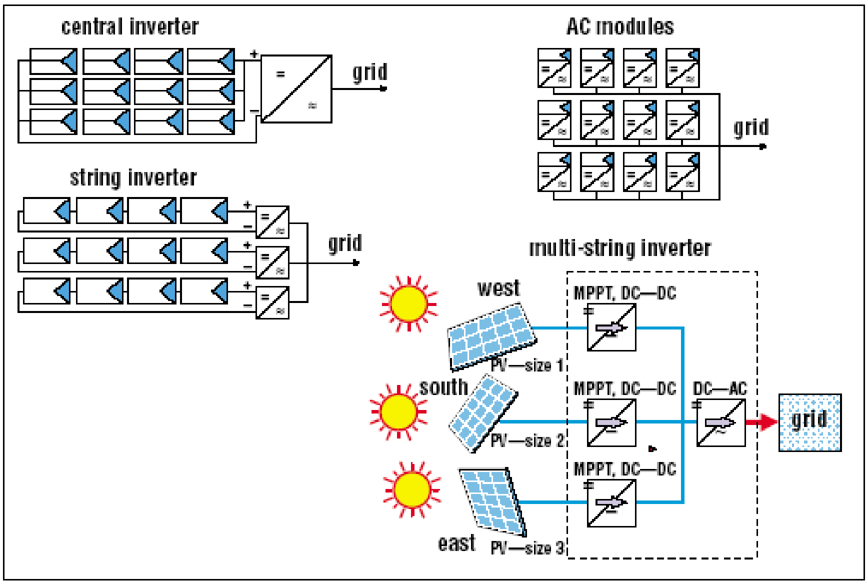


Figure 3.2: Basic design concepts for PV installations

The DC to AC electrical conversion efficiency is the most important parameter for grid-connected PV generation. Generally, the conversion efficiency is not constant, but depends on the actual load; it is relevant to know the efficiency at various operational levels. For fixed systems, the PV power has low levels in the morning and in the evening, with a maximum at noon (sinusoidal daily profile). Therefore, inverters are usually optimised for an efficiency maximum at about 50% of the nominal inverter power.

The European Efficiency of an inverter is defined by the following formula:

EE = 0.03 x E5 + 0.06 x E10 + 0.13 x E20 + 0.1 x E30 + 0.48 x E50 + 0.2 x E100
Where:

- EE is the European Efficiency
- EX means the efficiency at X% load factor

The design for this project is based on the central inverter concept. For such a design, some aspects related to the design of the PV plant and the selected inverter need to be considered:

- Strings connected to the same MPPT must have the same number of modules;
- The PV modules connected to each MPPT should have the same orientation and shading effects;
- It is recommended that the approval of the inverter manufacturer is obtained for the proposed design for each specific PV plant;
- A basic constraint on the number of PV modules connected to a single inverter is given via the maximum DC power input recommended by the inverter manufacturer; and
- For the strings to be designed correctly, two basic electrical constraints (introduced by the inverters) must be taken into account:
  - Series connection: the string size (i.e. the number of PV modules that can be connected in series) is basically limited by the inverter’s DC input voltage. Two main inverter variables must be considered here: 1) the maximum DC voltage, a value that must be cross-checked with the PV module’s open circuit voltage; and 2) the MPPT

voltage range, a value that must be cross-checked with the PV module's MPPT voltage.
- Parallel connection: the number of strings connected in parallel to an inverter is basically limited by the inverter's maximum DC input current. In addition, the maximum number of strings capable of being physically connected to the inverter must be checked.

These issues will be checked in separate reports ([2.1] and [2.2]).

3.2.2 AEG Power Solutions

Manufacturer presentation

AEG Power Solutions GmbH is a German based company employing approximately 1,500 staff worldwide. The history of the company has its origins in the founding of AEG in 1887. Development of power supply systems began in 1945 and the Power Solutions branch was formed in 2005 to supply power conversion and control devices for a wide spectrum of industries which require such equipment. The Renewable Energy Solutions segment, one of two strategic business segments (the other named Energy Efficiency Solutions) was formally created in 2005 to address the growing market for inverters and power controllers for the production of polysilicon, an essential raw material used in the production of solar cells. The company is based in Warstein-Belecke, Germany. Though it is not clearly specified, GL GH assumes that the production facilities for the inverters to be deployed for the project are also located at Warstein-Belecke. AEG Power Solutions does however have additional production facilities located in France, Spain, India, China, Malaysia and Singapore. Figure 3.3 presents the position of the company's products in the marketplace, as it was indicated in the information provided to GL GH.

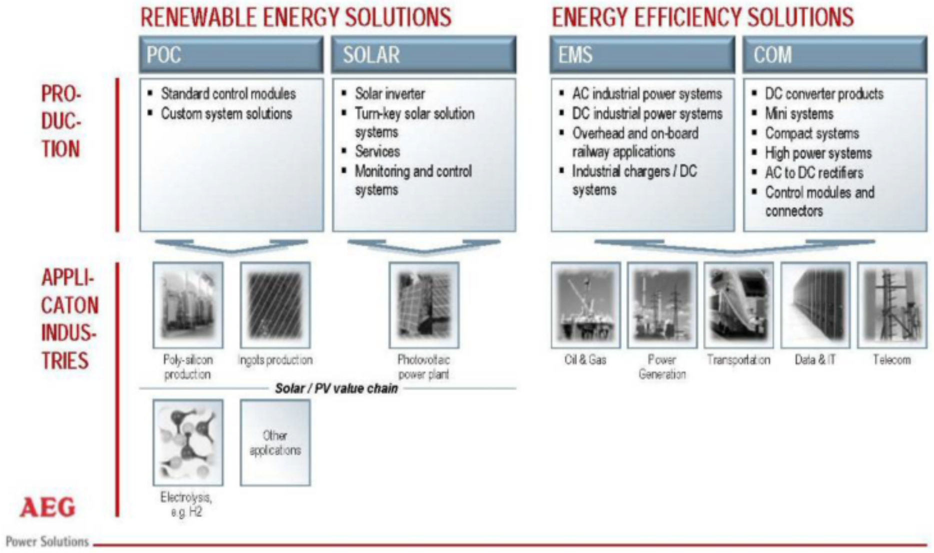


Figure 3.3: AEG Power Solutions product organization chart

The exact actual production and production capacity of AEG Power Solutions has not been provided to GL GH. However, it appears from industry news sources as well as company press releases that the firm intends to become a major player in the global market for solar power inverter systems. For example, in addition to its German based manufacturing facilities, in August of 2011, the company has initiated construction of a manufacturing facility in India to address inverter growth in that country, which they anticipate to total some 20.000 MW by 2020. Appendix 11 identifies some of the existing facilities where the Protect PV 250 is in operation.

In addition, AEG Power Solutions has the Quality standard ISO 9001:2008 certification. The corresponding Certificate, displayed on the company website, has been issued by TüV and is valid until April 2012. The firm has targeted 2011 to achieve ISO 14001 Environmental certification.

Inverter technical specification

The project sites will be supplied with AEG Power Solutions inverters of the following type:

- Protect PV 250, with an AC power of 255 kW (at unity).

According to company presentation materials, these types of inverters were introduced on the market for the first time in September 2009.

Two different configurations are available for the AEG Power Solutions Protect PV series of inverters, the Protect PV 250 and the Protect PV 500. The basic design of both inverters is similar in that they both use the Protect PV 250 basic design. The Protect PV 500 consists essentially of two Protect PV 250 inverters in one electrical cabinet, with the corresponding addition of necessary components to handle greater current requirements. The Protect PV 250, which is the subject of this review, carries the following Euro Efficiency:

- Protect PV 250 : without transformer (LV/MV) : 98.5%

Table 3.8 presents the relevant technical parameters of the inverters supplied to the Alfa and Zeta sites. In addition, the inverter data sheet can be found in Appendix 12. The Protect PV 250 data is provided for reference only. The technical specifications of these inverters are broadly similar to the market equivalent products, with the exception of efficiency, where it is slightly higher. The MPPT voltage range is 370 V for the PV 250 and 320V for the PV 500, which is considered to be in the middle part of the expected range for this type of inverter.

	Protect PV 250	**Protect PV 500**
Maximum Power DC input (kWp)	320	580
DC Voltage Range, MPPT (V)	450 - 820	500 -820
Max. Permissible DC Voltage (V)	1000	1000
Max. Permissible DC Current (A)	600	1060
MPPT Tracker	1	1
AC Output Voltage w/out transformer	255	283
Operating Grid Voltage AC (V)	400	400
Nominal AC Power (kVA)	255	510
Max. Efficiency (%)	98.7	98.4
Euro Efficiency (%)	98.5	98.15

Source: AEG Power Solutions.

Table 3.8:: Technical characteristics of the AEG Protect PV 250/500 inverters.

The acceptance from the inverter manufacturer, to use the Protect PV 250 with Jinko Solar, CNBM, or HHI PV modules, has not been provided. GL GH recommends requesting such acceptance letter specifically for these module types.

Certifications and warranty

Regarding the warranty of AEG Power Solutions inverter products, AEG provides a variety of warranty and maintenance agreements to keep the inverters in good working order. These agreements can vary from 5 to 20 years in duration. This kind of tiered warranty and maintenance agreement has become more typical in the central inverter marketplace. The details of this project's warranty agreement have not been provided.

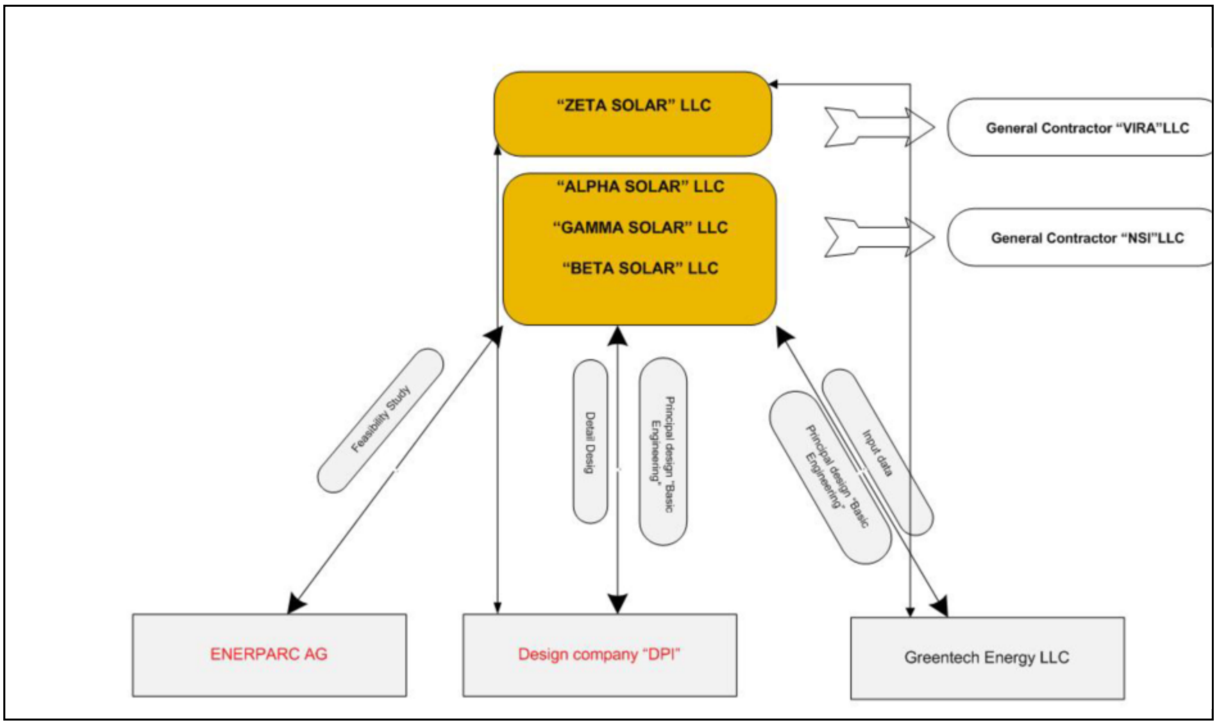
In addition, the Protect PV 250 inverter to be used in the project has been developed, constructed and manufactured according to the following EC directives:

- Electromagnetic Compatibility according to EN 61000-6-2 and EN 61000-6-4 has been qualified by Bureau Veritas and has been provided; and
- AEG Power Solutions provided documentation indicates that the grid monitoring is in accordance with standard DIN VDE 0126-14-1, with respect to the automatic disconnection of the grid compulsory since April 2008. The certificate has not been provided.
- Electronic Equipment and Safety is in accordance with EN 50178:1997 and EN 62109-1:2007 indicated under the CE mark, Document No. CE 0138, which has been provided (Appendix 13).

GL GH considers the AEG Protect PV 250 inverter technology a recent arrival into the market. The design has enjoyed rapid penetration into the central inverter PV market. However, AEG Power Solutions has its origins in the power supply systems division of AEG, which was founded in 1945, while the firm's current organizational structure was created in 2005. As such, it possesses a long history in the power electronics and control industry. The Protect PV 250 presents the typical expected certifications with an acceptable, if not very good, efficiency level. Therefore, GL GH considers the technical risk of the AEG product to be low. Nevertheless, GL GH still recommends the Client to request track records of field deployed units or independent review of the inverter to support claimed performance.

4 CONTRACT REVIEW

The Project is divided into four 20 MW PV plants. Each PV plant is represented by a dedicated SPV, and follows the same contractual scheme as shown in Figure 4.1, below. This analysis is focused on the Alpha Solar PV plant. Given the different types of contracts and documentation provided, GL GH has exclusively used the English versions. Some typos have been identified, due to the translations. GL GH did not review all the typos when the signification of the text was not two-fold.



Source: Activ Solar. *GL GH notes that Greentech is not presented as the O&M contractor and Activ Solar trading equipment delivery contract is missing.*

Figure 4.1: Contractual organisation

GL GH has reviewed the following contracts:

- Engineering Contract - signed between "Dneprovtsky Proentny Institut" (DPI) and Alpha Solar and dated 02 September 2010.
    - Field Supervision During Construction Contract between DPI and Alpha Solar, dated 23rd March 2011.
- Construction Contract between NSI Bud and Alfa Solar, dated 25 November 2011.
- Cables Procurement Contract, between Activ Solar Trading and Alpha Solar, dated 18 November 2010.
    - Addendum to this contract, dated 17 March 2011.
- Mounting Structures Procurement Contract, between Activ Solar Trading and Alpha Solar, dated 18 November 2010.
    - Addendum to this contract, dated 28 March 2011.
    - Addendum to this contract, dated 01 June 2011.

- Contract of Equipment Delivery, between AST Activ Solar Trading and Alfa Solar LLC and dated 18 November 2010.
- Operation and Maintenance Draft and its Appendices. This document is in progress and the contractor will be GreenTech Engineering LLC, providing O&M services to Alpha Solar.

Given the unusual number of contracts for a PV plant, GL GH has undertaken analysis of the provided contracts, as follows:

- Section 4.1: Presentation of the different contractors;
- Section 4.2: Review of the DPI contracts;
- Section 4.3: Review of the NSI contract;
- Section 4.4: Review of the Activ Solar Trading supply contracts;
- Section 4.5: Review of the Activ Solar Trading equipment delivery contract;
- Section 4.6: General construction contract recommendation;
- Section 4.7: Review of the O&M contract.

The term "EPC contract" is used regularly throughout the contract review. It is understood that the contracts reviewed are neither of an EPC nor a turnkey type. Nevertheless, when "EPC contract" is used, it is to provide reference within the industry.

4.1 Contractor Overview

DPI:

Dneprovsky Proektny Institut (DPI) is a Ukrainian state-owned company. It provides concurrent engineering for the construction of industrial, housing, civil and institutional structures within various functional designations, which includes the conduction of surveys, development of construction projects and field supervision of project decision implementation. The company presents several track records in spatial infrastructure and a PV Plant of 7.5 MWp in Rodnikovoye for Activ Solar. It is a local engineering company which is able to apply local constraints to any Solar PV project.

NSI

NSI Bud Company (NSI) is an important building enterprise in Ukraine. Founded in 1993, the company has conducted a broad spectrum of constructional projects, including technologically complex large structures. NSI has played the role of both prime contractor and construction managing contractor.

The range of services covers:

- New construction;
- Repairs and reconstruction/reengineering;
- Construction sphere management;
- Commissioning of buildings completed.

The company has a state licence for the execution of all construction work in Ukraine. It had a €24m turnover in 2010. The company's track records are mainly in infrastructure, with experience in the Solar Business gained from involvement in the 7.5 MWp plant in Rodnikovoye for Activ Solar.

Activ Solar

Activ Solar GmBH is the Sponsor of the project and Activ Solar Trading LTD is the main contractor for the project. The Activ Solar Company is present in Solar at different levels. The company has been producing Trichlorosilane, Poly Silicon and ingots in the OJSC Semiconductor Plant since 1964. Furthermore, the company develops, finances and operates projects in Ukraine.

In 2009, Activ Solar signed a Memorandom of Understanding with the Crimean Government and utility to develop up to 1 GW of solar PV projects; its first power plant, of 7.5 MWp, has been commissioned in Rodnikovoye in January 2011. A new PV plant of 20 MW, part of larger portfolio of 80 MW has also been commissioned in May 2011 n Okhotnikovo. Activ Solar Trading LTD is the main contractor of the Alpha SPV project during the construction phase. The cumulated price of the three contracts considered represents around 92 % of the CAPEX given in the financial model.

GreenTech Engineering LLC

Greentech Energy is the O&M contractor of the Alpha Solar project. Greentech Energy provides full-service project design, engineering and O&M solutions for solar and wind power stations in Ukraine. The company was created in 2011 and has a staff of 50 people. The company's track records as O&M contractor are the 7.5 MWp plant in Rodnikovoye commissioned in February 2011 and the 20 MWp plant in Okhotnikovo commissioned in May 2011.

4.2 Review of the Construction Contract

The process of construction is as follows:

- Several contractors have been preselected to carry out part of the construction work for the Alpha Solar project (and for the other projects within the Portfolio). A general agreement, such as that commented on in the relevant section of this report, has been signed with each potential contractor.
- For each task that needs to be undertaken by a constructor, a tender is prepared between the pre-selected contractors. Each bidder submits its conditions for price and delays in a commercial proposal. When the company for a specific task is selected, it then submits an "act of rendered services". This act provides the price and conditions of the task as an addendum to the main agreement.

The contract is a general agreement between the SPV and NSI for "the building activities for solar power plant situated in the Autonomous Republic of Crimea, Simferopol region, Perovski village council". The Sponsor has indicated that NSI should be the preferred contractor for the Alpha Project.

GL GH would comment on the general contract agreement with NSI as follows:

- The liquidated damages in case of a delay are set to 0.05 %, per day of the cost of each rendered service, limited to 5 % (section 6.1). GL GH found this to be rather a low liquidated damage for one day and a low cap value, compared to the loss of income, but this is mitigated by the fact that only part of the work will be done and (in the case of a serious issue) the contractor may not be selected for further work on the project;
- In case of a serious defect, a penalty of 10 % will be paid and it will not relieve the contractor from its obligation to finalise the work according to the contract (section 6.2 and 6.3). This is acceptable for such a contract; ***nevertheless, the notion of serious damage should be clearly defined;***
- The guarantee is valid for 12 months (section 10.1). It is standard in the construction industry, but it needs to be analysed with regard to the overall warranty condition of the PV plant. This point will be detailed in the general recommendation for contracts;
- In section 10.6, the damages caused by the contractor are compensated for by the contractor. Since the contractor will work with high price materials (modules, inverters, etc.), GL GH recommends contacting the insurance advisor in order to check that the contractor's insurance policy is able to cover the costs of these products;
- Given the organisation of the work, it is difficult to anticipate the final cost of construction. This point will be detailed in the general recommendation for contracts;
- In case of damage to the materials (on the modules, for instance), the Contractor should pay the reparation and replacement costs, if any.

A list of acts of rendered services has been provided for NSI, with the associated prices which are detailed in Table 4.1.

Task Undertaken by NSI	Total (UAH)	€
Alfa Solar. Protection. Length of 2900 rm.	539,400	49,215
Alfa Solar. Foundations under inverters.40 pcs.	800,000	72,993
Alfa Solar. Editing and fixing of the inverter stations. 40 pcs.	400,000	36,496
Alfa Solar. Assembling and installing of base surfaces. Area of 1-20. 63720 rm.	3,823,200	348,832
Alfa Solar. Pile ranck with Customer machines (38522 pcs). Area 1-20.	2,503,930	228,461
Alfa Solar. Pile ranck with general Contractor machines (1816 pcs). Area 1-20	172,520	15,741
Alfa Solar. Pile ranck with Customer machines (1099 pcs). Area 1-20.	71,435	6,518
Alfa Solar. Assembling and installing of base surfaces. Area of 21-29. 25207,7 rm	1,512,462	137,998
Alfa Solar. Electrical installation works	8,000,000	729,927
TOTAL	**17,822,947**	**1,626,181**

Source: Activ Solar Ukraine

Table 4.1: NSI prices and tasks undertaken

The tasks undertaken seem to cover most of the on-site work necessary for the construction of the project. It is nevertheless neither a comprehensive list nor a fixed price for each of the projects. However, the total price does not exceed the 3 % of the CAPEX shown in the financial model (see section 6.3). Therefore, the risks associated with an exceedance of construction work are somehow mitigated, with regard to the global investment of the project.

4.3 Review of the Engineering Contracts

Project and working documentation

DPI has been contracted for the integration of the basic engineering document provided by Activ Solar. The work consists of integrating the design into the local regulations and infrastructure and of realising the as-built documentation of the plant.

GL GH’s comments on this contract are as follows:

- There is two discrepancies in the translation in supplement 1: the price indicated is not the one provided in the contract. GL GH has received confirmation from the Sponsor that the correct price to consider is 820,000 UAH. Moreover, the reference of the contract is indicated to be 1557/11, when is it is actually 1557/9. ***It should be clarified***;
- The contract may be subject to modification in terms of scope and price. It can be mitigated by the fact the contract price represents 0.1 % of the CAPEX.

Field supervision contract

In addition to the contract for the engineering documentation, DPI has been mandated in order to ensure supervision of the plant construction. The contract is signed for five months; DPI shall follow the progress of the work and shall be responsible for acceptance of the conducted work. Therefore, the final executed works will have been both designed and verified by the DPI Company.

GL GH’s comments about this contract are as follows:

- The price of the contract being negligible in front of the overall CAPEX, the commercial conditions of this contact should not threaten the global investment that will be needed to commission the Alpha Solar PV plant;
- This contract, as well as the above contract, impacts the responsibilities between Alpha Solar and the SPV of the Activ Solar Trading Equipment contract, detailed in Section 4.5. This specific issue will be detailed in the general recommendation for contracts.

4.4 Review of Activ Solar Trading Supply Contracts

This section summarises the main findings from the review of the Activ Solar Trading contracts and appendices provided by the Client. GL GH reviewed each of the contracts and addenda, as well as the attached appendices.

Cable contract and addendum

The contract is a simple supply contract for cables. All the cables needed for the PV plant have been included, from DC cable to communication and optical fibre cables. The addendum provides two main changes which are as follows:

- Price diminution and scope decrease (number and length of cables minimised) due to the latest engineering studies; and
- Latest delivery postponed from September 2011 to December 2011.

GL GH's comments on this contract and its addendum are as follows:

- The design documents and the number of parts ordered are in line with the provided design;
- The price of €0.289/Wp for a 20 MW project seems rather a high price, compared to the market standard;
- The INCOTERM of the delivery is DDU Perovo, Crimea, Ukraine, but the delivery terms considered are the shipment from Berlin. This may lead to confusion in the organisation of the project. Therefore, the delivery date should be stated in Perovo;
- There are no details about the technical specifications of the cables. GL GH recommends adding an appendix linked to the engineering specifications;
- The contract price is based on the engineering study. Besides, the ultimate responsibility for the engineering is Alpha Solar, through its contract with DPI. Therefore, any change in the drawing may change the sizing of the cables and lead to a tariff increase. This point will be detailed in the general recommendation for contracts and in the financial model review; and
- In case of delay, no liquidated damages have been introduced in the contract. This point will be detailed in the general recommendation for contracts.

Mounting system contract and addenda

The contract is a simple supply contract for mounting systems. A breakdown of the separated parts is provided in appendix. The two addenda provide three main changes, which are:

- Details of the buyer changed;
- Scope modification, the price being steady;
- Latest delivery postponed from September 2011 to December 2011.

GL GH's comments on this contract and its addenda are:

- GL GH checked the design documents and the number of parts ordered is in line with the provided design;
- The number of parts required for the 20 MW plant (and its exact function in the mounting systems in the plant) is not clear. ***This should be clarified.***
- The price of €0.233/Wp for a 20 MW project seems rather a high price, compared to the market standards;
- The INCOTERM of the delivery is DDU Perovo, Crimea, Ukraine, but the delivery terms considered are the shipment from Berlin. This may lead to confusion in the organisation of the project. Therefore, the delivery date should be stated in Perovo;

- There are no details about the technical specifications of the mounting system. GL GH recommends adding an appendix linked to the engineering specifications;
- The contract price is based on the engineering study. Besides, the ultimate responsibility for the engineering is Alpha Solar, through its contract with DPI. Therefore, any change in the drawing may change the sizing of the mounting systems and lead to a tariff increase. This point will be detailed in the general recommendation for contracts and in the financial model review; and
- In case of delay, no liquidated damages have been introduced in the contract. This point will be detailed in the general recommendation for contracts.

4.5 Review of Activ Solar Trading Equipment Delivery Contract

4.5.1 Scope of work

The scope of the contract has been separated into two types, equipment and services, both of which are detailed in separate appendices. Section 3.2 also details the basic engineering documents to be provided within the equipment section.

Equipment and engineering (schedules 1 and 3)

The equipment is itself divided into two sections - “Solar modules” and “System of Container” Station. An exclusion list is also provided, to clarify the limit of the equipment (and services).

Solar modules

The description of Solar modules is a single sheet of technical characteristics. The modules are detailed as 20 MWp of Solar modules, from 220 Wp to more. The modules are specified as “produced strictly according to specifications”. This is not acceptable. The modules are known by the Sponsor to be CNBM and JINKO Solar modules, manufactured in China. GL GH strongly recommends updating the appendix (as well as all the other documentation) with the brand of the module manufacturer.

Section 3, the technology review, gives GL GH’s opinion on the products, based on the documents provided. The warranty issue will also be commented on further in the warranty section of this contract.

Moreover, GL GH strongly recommends including in the scope the independent analysis of a sample of each type of module by an independent laboratory, in order to control the products delivered.

System of solar inverter container stations

The description of the substation is a very short description, without any reference to norms, specification and/or drawings. This is not acceptable. The complete substations are known by the Sponsor to be AEG systems. Therefore, a complete specification of the systems should be linked to the contract.

Activ Solar has provided GL GH with the name and brand of the pyranometer used: CMP11, from Kipp and Zonen. This is a secondary standard pyranometer, according to the ISO 9060. GL GH considers this acceptable; nevertheless, the reference and specification of the pyranometer should be indicated in the contract.

Engineering

The initial engineering documentation shall be undertaken by Activ Solar.. Schedule 2 describes the first initial engineering documentation to be provided. GL GH considers the list of documents corresponding to a complete first engineering documentation.

Exclusions

The following exclusions are considered in the contract:

- Any Civil building construction and foundation;
- Equipment unloading, moving-in, storage and loading;
- Authority engineering, operational permit applications and certifications;
- H&S related to construction;
- Direct lightning protection system;
- GSM/satellite connection;
- Cables for modules and power station connection;
- Mounting systems.

The exclusions and complementary contractual conditions in the other contract will be reviewed in section 4.6; nevertheless, GL GH will need clarification of the following:

- ***What is defined as direct lightning protection***? What would consequently constitute indirect lightning protection;
- The cables for modules and power station connection ***should be clarified***, since many cables link the modules to the power station, including the cables which should be part of the modules.

Moreover, the contract has a specific scope of buyer responsibilities, with its schedule 5 in the appendices specifying the infrastructure preparation of the project required before any start of work, which consists of:

- Phone line installation;
- Warehousing installation;
- Site security installation;
- Site facilities installation;
- Management of waste preparation;
- Health and Safety organisation.

Services (Schedule 2)

Supervision of equipment installation

The contractor will supervise the installation works during the construction. For this, the basic engineering documentation provided by the contractor to Alpha Solar will have been validated by a "Certificate of acceptance of the Basic Engineering" and signed by Alpha Solar and DPI. This certificate should have been issued in 2010 ***and it needs to be provided to GL GH for review***.

The final engineering documentation issued by DPI, under the responsibility of Alpha Solar, should be provided to the Contractor for review, together with the site preparation.

The contractor will eventually issue a certificate to state that the commissioning (start up) of the plant may occur. The responsibility for installation remains with Alpha Solar and its subcontractors (NSI, DPI, and/or others).

Commissioning of the equipment

The contractor will also supervise the SPV's work during commissioning and will then issue a report.

Training

The contractor will provide practical training for the Sponsor's team on the PV plant in Ukraine and theoretical training in Germany. ***Clarification of project management during the operation should be provided to GL GH***. This way, the training that would occur should be organised for the O&M contractor and/or for the Sponsor specialist, if any.

4.5.2 Price and milestones payments

The price of the contract is fixed, unless appended to the contract. Table 4.2 shows the breakdown of prices. For the part relating to equipment there is no milestone payment and the drawdown will be issued upfront, proportionate to the goods delivered. For the services, payment will be made after commissioning of the plant and a maximum of two months after mechanical completion. GL GH considers this is negligible with regard to the project cash flows.

Item	Price €	Price €/Wp
Solar modules	46,080,000	2.304
System of Solar inverter container Stations	9,958,000	0.498
Services	15,000	0.001
TOTAL	**56,053,000**	**2.803**

Table 4.2: Contract price breakdown

GL GH's comments, with regard to the price and milestone payments, are as follows:

- The PV module price of €2.304/Wp for a 20 MW project seems rather a high price, compared to the market standards;

- The system of solar inverter container station prices (of €0.498/Wp for a 20 MW project) is within the highest range of market standards;
- The service price is underestimated for correct supervision;
- The custom import taxes are not part of the price. GL GH recommends including these in the contract;
- Schedule 1 stipulates the "acceptable variation of total Wp quantity in +-1". This ***should be clarified***, since different interpretations could lead to a very different result. Moreover, GL GH understands that the price is fixed, even if the module delivered is lower than the 1 % agreed in the contract; this is unclear and it is not acceptable. The contractor should specify that the module nominal power installed should be a minimum of 20 MWp. The tolerance of each module being +-3 %, the sum of the maximum power in the flash list should not be lower than 20 MWp;
- Since installation is not the responsibility of the contractor, the provision for spare parts and destruction of material during the installation is not provisioned. A minimum of 0.5 to 1 % of additional power should be included in the scope of the contract;
- The payment will be upon each delivery of material, leading to a contract which is fully paid before any tests have been carried out at the PV plant, in order to validate the output power delivered. This is not acceptable, a minimum of 5 % of each delivery should be held until the plant has been certified (and all tests have been passed).

4.5.3 Completion and testing

The different steps of the project's construction are shown in section 11 of the contract. The Contractor, the Sponsor and the Engineering Company (DPI) are involved up to the point of completion and testing. The Sponsor needs to prepare the entire preliminary infrastructure, prior to delivery of the material. Once this preparation is done, installation shall begin and be terminated in accordance with schedule 7 of the contract.

After accomplishing installation of the equipment, the three companies sign a Certificate of Equipment Installation Completeness; this is a kind of mechanical completion certificate. Once it has been signed, the testing period begins, which is called "ramp up". Once the tests have been passed, the three companies sign the certificate of ramp up of the equipment; this is also sometimes called "provisional acceptance". Schedule 4 details this last certificate.

GL GH's comments on completion and training are as follows:

- The two certificates should be validated by a comprehensive list of documents. Schedule 4 is rather a short certificate. All the PR reports, the ramming tests, the certificate from the state about safety on-site, the earthing measurements, the as-built documentation and the check list, should form part of the acceptance of this PV plant. A typical list of documents to be provided for provisional acceptance of such an important PV plant is added in appendix 14 of this report.
- There is no punch list associated with mechanical completion and provisional acceptance. This is due to the fact that the construction responsibility remains with the Sponsor. A punch list with a six-month deadline, with no item impacting the safety of the plant or the good production of the plant, shall be signed during provisional acceptance.
- Schedule 7 is more a delivery deadline than a definite date for completion - this will be analysed in the Time Schedule section.

- There is not definition of completion tests and of figures that should be reached during these tests. GL GH recommends (see below) that tests are carried out in order to certify the provisional acceptance.

The expected completion tests for provisional acceptance to be passed by the Contractor should be an availability test and a performance ratio test:

- The tests need to be reproduced until reference values have been obtained:
  - The expected availability reference figure during this test is 99 %, minimum;
  - The PR ratio tests reference figure should be 95 % of the theoretical performance ratio to be agreed between the parties, based on a third party PR analysis.
- Both tests should be based on a minimum of 21 continuous days.
- Schedule 6 introduces an interesting pre-test protocol, providing conditions for collecting and analysing the PR. GL GH recommends following the same trend, with the following proposed modifications:
  - The PR definition should be modified. GL GH suggests that the Eideal formula is replaced by: Eideal = GInc x Pstc, where Pstc represents the PV plant nominal power (based on the sum of the installed Pnom of each module);
  - There should be at least two reference sensors to calculate the irradiation. This way, the average of the sensors' output will be considered as a reference when both are functioning, and one will provide backup for the other in miscellaneous cases. The sensors should be free of any shadings;
  - The test duration should reach a minimum of 3 weeks continuous measurements in order to be valid;
  - The irradiation considered for the tests should be above 70 W/m²;
  - If an availability test is added to the contract, the warranted and calculated PR should not take into account the unavailability of the plant.
- Once the tests have been passed, the Contractor should provide a report detailing the protocol used with the results to the Sponsor, for validation. The Independent Engineer will review this document, as well as the raw data, as part of the provisional acceptance process.

4.5.4 Warranties and penalties

The contract warranties are described in sections 9, 10 and 13.

Material warranty

The equipment will be warranted either from the point of completion of the certificate of equipment installation or a maximum of 3 months after delivery of the last parts. A 24-month warranty from the Engineering Company will be issued. The O&M contract refers to a 24-month Defect Notification period, during which the Builder will be responsible for any corrective maintenance. Schedule 8 is the form of the warranty. The material warranty included in the contract, and detailed in schedule 8, is insufficient. The document is only a "warranty for basic engineering" which is not detailed at all. GL GH recommends providing a standard material warranty, adding workmanship, in case the O&M contract does not take this into account during the first two years. GL GH also recommends discussing the validity of this warranty with the legal advisor.

The standard module and inverter warranties are usually expected to be 5 years. Therefore, the O&M warranty should cover these additional years. It will be detailed in the O&M contract section.

Performance warranty of the plant

According to the standard of the industry, the EPC contract, together with the O&M contract, should provide a good level of performance to the plant, with the combination of two different types of warranties:

- Availability warranty: the availability is the proportion of time a system is in functioning condition. The availability warranty is thus the image of the quality of the material (mainly inverters and electrical parts) and the works (correct connections for instance) that are part of the EPC contract. It is also an image of the performance of the O&M contractor, when it comes to quickly reacting and changing the defective parts in the smallest amount of time possible. An availability warranty's typical figures are 99 %, for ground plants.
- Performance ratio warranty: the performance ratio warranty is the representation of the performance of the selected components in the EPC contract (module and inverter efficiencies) and of the O&M interventions (for example, soiling). The standard IEC 61724 is the preferred reference, when implementing such a warranty.

The validity of both warranties is limited to the parameters over which the contractors may have influence. Therefore, there is always a force majeure case list available, to limit the responsibility of the contractors (EPC and O&M). The PR and availability warranties shall ideally be bound to the EPC contracts; however, often, a combination of the warranties can be found in the standard contracts. GL GH's suggestion would be a PR warranty in the EPC and O&M contract and an availability warranty in the O&M contract (it will be reviewed in section 4.7).

There is no availability warranty. However, this is mitigated since the O&M contractor is providing the availability warranty from year 1 of operation.

Section 13, together with Schedule 6 in the contract, details the PR warranty set forth in the Activ Solar Trading contract. GL GH comments on the performance warranty of the plant. The PR warranty is a 5-day to 14-day test which is linked to liquidated damages in order to validate provisional acceptance; this is no more a completion test (such as that described in Schedule 6) than a standard warranty. Moreover, the calculation of liquidated damages is not clear. The output reach in PR is understandable, but the output reached in power is not. ***These points should be clarified***. The following are recommendations for the definition of a standard warranty:

- The performance ratio (PR) reference of 77 % should be validated by an independent EPA - GL GH suggests setting it to 95 % of the EPA result.
- The duration of the warranty should be set to 2 years, ideally, to be in line with the mechanical warranty - this would set the final acceptance at two years after the take over.
- The procedure is not detailed enough, and the following comments concern schedule 6:
  - The PR definition should be modified. GL GH suggests that the Eideal formula is replaced by: Eideal = GInc x Pstc, where Pstc represents the PV plant nominal power (based on the sum of the installed Pnom of each module);
  - There should be at least two reference sensors for calculating irradiation. This way, the average of the sensors' output will be considered as a reference when both are

  - functioning and one will be backup for the other in miscellaneous cases. The sensor should be free of any shadings;
  - The irradiation considered for the tests should be above 70 W/m².
- When assessing the liquidated damages calculation in PR, it seems that the level of liquidated damages is underestimated. The percentage of non-fulfilment should be linked to 100 % of the purchase price. Moreover, the cap price should be increased to cover 4 to 5 years of loss of income.

Installed power

There is no condition for real power estimation and price modification in the contract. GL GH has addressed this issue in section 4.5.2.

Delays

Section 12.1 details the penalties to be applied for a late delivery. Since the contract is a supply contract, the penalties are applied to the part of the delivery involved and to the associated costs. After a 2-week grace period, the penalty will be 0.3 %, per additional week of delay. This is limited to 3 % (12 weeks). Moreover, the Sponsor needs to prove the negligence of the contractor in order to get the payment. This is not acceptable, and GL GH recommends the following modifications to the agreement:

- The cap price of delay penalty should be set to a minimum of 10 %;
- The contractor should be responsible for proving that the penalty is not justified.

Overall cap for penalties and liquidated damages

The contract gives a limitation of liability of 40 % of the contract price (section 12.2). It is clearly stated that it covers the PR, the delays and all liabilities.

GL GH recommends setting a cap for the liquidated damages at 40 % and a liability limitation (in case of breach of contract, for example) at 100 % of the contract value.

4.5.5 Final acceptance

There is no final acceptance specified in the contract, but the end of the warranty period of 2 years should be the final acceptance date. GL GH recommends detailing this milestone.

The final acceptance is pronounced at the end of the warranty period. The punch list must have been addressed and the production needs to reach the warranties provided in the EPC contract. A third party shall control the production and liquidated damages linked to the warranty (if any) shall be paid to the Sponsor. A typical list of documents to be provided for the final acceptance of such an important PV plant is added in appendix 14. The PR should be controlled for at least the first year after takeover; yearly control until the end of the warranty is recommended afterwards.

4.5.6 Bank guarantees and bonds

There are no bank guarantees for the project. For this type of project, an advance payment guarantee is expected to be provided by the Contractor to the Sponsor. This can be mitigated by the fact that, according to the Sponsor, more than 90 % of the work has been already achieved. Nevertheless, this kind of guarantee should be enclosed in the next projects' contracts - those for Beta, Gamma and Zeta Solar.

A bank guarantee is also typically provided, in the case of availability and performance warranty in the EPC contract, which is linked to liquidated damages (and assessed every year until final acceptance). GL GH recommends including a bank guarantee for final acceptance.

4.6 General Construction Contract Recommendations

In order to achieve the construction of the Alpha Solar Project, several contractors are engaged via different contracts. Table 4.3, below, is a summary of the responsibilities and interactions within the contracts reviewed. For all these contracts, the Client is Alpha Solar. In the Table, the sign "X" shows the contractor/company that will do the work or provide the service indicated on the left. The sign "i" indicates that the fault of the party responsible for the tasks may implicate another subcontractor and possibly reduce its responsibility to Alpha Solar. It is understood that Alpha Solar is implicated in all tasks. Finally, the sign "?" is drawn when the tasks are part of the contract but remain unclear. When the tasks indicated in the matrix are not part of any contract reviewed, GL GH assumes that Alpha Solar was ultimately responsible for these.

	Alpha Solar	**Activ Solar Trading**	**DPI**	**NSI**
Development	X			
Basic Engineering		X	i	
Engineering integration		i	X	i
As-built documentation		i	X	i
Site preparation	X			
Project management	X			
Delivery of modules, inverter stations, cables and mounting system		X	i	i
Grid connection	X			
Construction		i	i	X
Supervision during construction		i	X	i
Support for construction, commissioning and training		X	i	i
Completion		X	i	i
Construction warranty: 12 months		i		X
Mechanical warranty: 24 months		X		
PR warranty		?		
Availability warranty	O&M			
Contingencies during construction	X			
Inverters warranty	O&M?	?		
Module warranty		?		

Table 4.3: Responsibility matrix

Activ Solar GmBH, which is the Owner of Alpha Solar, is using the services of Activ Solar, Ukraine, and Activ Solar GmBH for the development of the project, as well as for coordination and management during construction. This relationship is not formerly written into any contract.

GL GH highlights the main risks of the contractual structure in the following paragraphs and gives its recommendations in order to minimise them. It is obvious that the risks would be mitigated optimally if the table above would have no "i" and no "?".

Overall warranties

The warranties that are provided by the main contract and detailed in the section 4.5.4 of that report are not sufficient. It is summarised in Table 4.4 below. Moreover, there is no warranty provided by the cable and mounting systems contracts. This is not acceptable.

Finally, the method for transferring the warranties from the manufacturers of main components to the SPV is not detailed in the contract. For instance, no 25-year power warranty for PV modules has been included in any of the contracts reviewed.

Equipment	**Warranty Period**
PV modules, inverter containers, junction boxes, monitoring stations	2 years - ***unclear***
Cables, mounting systems	**Missing**
Standard material manufacturer warranties (modules, inverters)	**Not provided**
Construction	**Warranty Period**
Construction works	12 months
Performance	**Warranty Period**
Availability	Missing
Performance ratio	**Missing**

Table 4.4: Construction warranties

Price

The contract price is fixed for the Activ Solar Trading contracts. Some recommendations have been made in response to this in section 4.5.2. The other contracts do not have a fixed price and several extensions of the work could be expected to occur during the construction of the project; this is a risk to the project budget.

Moreover, as it is highlighted in the financial model (see section 6.3), the CAPEX costs are not all covered by the contracts reviewed.

Responsibilities

Given the number of contractors and the relationships between the SPV and different contractors, many responsibilities are shared, as is shown in Table 4.3. Indeed, every time an operation made by a subcontractor implicates another, the potential defect (such as delay, broken parts or errors in design) of this operation could lead either to minimising or to dismissing the responsibility of the other contractor who is implicated. Ultimately, the SPV may not be covered and will therefore be subject either to a price increase or to a lack of warranty. For example, the length of cables is defined by the Engineering Company. If there is a change in the definition, then the new price will be defined by Activ Solar Trading. Eventually, Alpha Solar will support the new cable costs.

Conclusion and identification of mitigation factors:

GL GH understands that the same contractual structure has led to the 7.5 MWp Rodnikovoye PV plant, commissioned in February 2011 (the first part of 2.5 MWp were commissioned in September 2010). This plant is the largest Ukrainian PV Plant commissioned, to date. However, this project is not subject to this Due Diligence analysis and no information about its operation and construction quality has been provided.

In the particular case of the Alpha Solar project, risk relating to the construction relationships and responsibilities can be mitigated, since the works show progress of around 90 % on-site based on the figures provided by the Sponsor. GL GH has not been provided with detailed progress reports, but some pictures of the ongoing Alpha Project have been made available by Activ Solar. However, since this report will be used for the remaining contractual scheme of the 80 MW project in Perovo, this mitigating factor is applicable to the Alpha Solar project only.

In order to accord with market best practice, GL GH would suggest one of the following solutions:

(i) Activ Solar Trading, who is the main contractor (up to 90 % of the CAPEX engaged in his invoices) becomes the real EPC contractor and subcontracts everything in order to deliver a turnkey contract;

(ii) A new contract between the SPV Alpha Solar and Activ Solar Gmbh, or one of its subsidiary, is created to cover the tasks under the SPV responsibilities and not part of the EPC contract;

In both cases, the risks defined above can be mitigated by adding the following conditions:

- Enclosing the recommendations made in the previous sections - with particular attention being paid to the completion and warranty conditions;
- Enclosing a provision for contingencies in the financial agreement, thereby limiting the CAPEX engagement for the Lenders;
- The transfer of ownership and warranties should be clearly identified in the contracts;
- Since the O&M and EPC contractors are different, the EPC contractor should be responsible for training the O&M contractor and for delivering a Certificate to the operator, which covers the Sponsor for disagreement between the O&M contractor and the EPC contractor during the PR warranty.

4.7 Review of the O&M Contract

This section summarises the main findings following the review of the O&M contract and the appendices provided by the Client. The contract is in progress and has not yet been signed by the parties concerned. GL GH notes that the O&M contractor (expected to be GreenTech Engineering LLC) will be different to the construction contractors of the project. Therefore, a specific agreement to accept the plant and be able to provide independent warranties could be requested by the O&M contractor.

In the interests of clarifying the terms of the contract, the O&M contract refers to the "Builder" for the construction contractor. At this stage of the project, no proper "Builder" is defined since the construction is not managed through a single contract, as commented in the previous Section. Therefore, given the current structure with the existing contracts, it is assumed that the Builder is the SPV (ergo, Alpha Solar).

4.7.1 Scope of work

The scope of work described in section 2 of the contract is divided into two parts, the preventive maintenance part and the corrective maintenance part.

GL GH's comments on the main tasks of this scope of work are given below:

a) Preventive maintenance:

There is a control visit planned every year, with a systematic list of duties to be carried out. GL GH considers the list of tasks described, in the annexes and in the main contract, to be reasonable. Nevertheless, it is understood that the maintenance of the security system is included in the contract but that the security itself is not. The security could also be included in the contract, since the maintenance operator is in direct contact with all the suppliers, network operators, etc.

The annual cleaning (twice a year, at a minimum) of the PV modules is included within the scope and price of the contract. This is considered reasonable, even if specific snow conditions should be analysed in order to optimise the cleaning periods for the modules.

The preventive maintenance also includes minor repairs, defined as being under €200. As even minor repairs are part of the corrective maintenance, this should be included in the corrective maintenance section.

b) Corrective maintenance:

The corrective maintenance scope of work that will be included in the contract is mainly described in the price section of the contract (section 3). The corrective maintenance work will start two years after the takeover of the plant, which is also the expiry of the defect notification period.

The work that will be undertaken by the Contractor will be based on the spare part list, with the exception of the modules that will be detailed in the next paragraph. The contract includes the acquisition and replacement of any material in the spare part stock list. However, the first acquisition of the spare part stock is under the responsibility of the SPV. The labour associated with the works for replacement is also included, at no additional cost.

The replacement of modules will be invoiced separately. In any case of warranty claims or the installation of more than 100 modules per year, the labour costs for module replacement is not included.

GL GH's recommendations for the scope of the work are as follows:

- The construction contracts should provide a material warranty to complete the warranty from the construction contracts. The corrective maintenance tasks should start from the beginning of operation of the plant. If the initial material warranty from the Builder excludes the labour costs, the O&M contractor should include the labour costs of corrective maintenance during the defect notification period;
- The contract should give more responsibility to the Contractor. For instance, the contract should include the replacement of any material, except for the modules. The minimum stock of spare parts that is paid by the Sponsor should therefore be defined accordingly with the O&M contractor;
- The stock of spare parts list should be detailed and should include all the parts needed for operation of the plant. Some discrepancies between the Engineering contracts and the spare parts list have already been identified, such as: the module brand is indicated as Yingli in the spare parts list, when they are in fact Jinko and CNBM modules; the size of the DC cables is indicated in the spare parts list as 6 mm², when it is in fact 4 mm² in the engineering documents;
- The stock of spare parts list included in the appendices should include a greater number of modules, 30 kWp being quite low - GL GH recommends between 0.5 and 1 % of the total power installed from each type of module (leading to more than 100 kWp stock).

Finally, based on maintenance of the inverter section in the technical annexes, the replacement and warranty of the inverter is not included in the scope of work, since there is a service agreement between the Builder of the Plant to replace the Inverters. GL GH has not been provided with this agreement, ***but the point should be clarified.***

4.7.2 Contract term

There is no term indicated in the contract. The start of the O&M contract is at the take over signature. GL GH suggests a term which starts at the first energisation instead, giving some time for the O&M operators to work and to witness the completion tests. The responsibility of the tests shall remain to the EPC contractor.

GL GH recommends that this term reaches at least 10 years, in accordance with the best of market practice.

4.7.3 Warranties and liquidated damages

Section 7 in the contract details the warranties included in the agreement. Two warranties are part of the contract: mechanical and availability warranties. The title of section 7 should be changed, since it only indicates the availability warranty, not the mechanical warranty.

The guaranteed availability levels are not indicated in section 7. However, the appendix shows that the contractor starts to pay liquidated damages for the first year if the availability is below 98 % and for the following year if the availability is below 99 %. The level of the warranty is considered to be acceptable.

Liquidated damages for non-compliance with the availability warranty should also be part of the contract, instead of only being in the appendix. It should reflect the loss of incomes suffered by the Sponsor. Since there is no price in the contract, GL GH was not able to check the level of liquidated damages. GL GH also highlights the fact that it is possible to include a bonus, to be paid to the contractor when the contractor achieves a higher level of performance than the contractual level.

The cap price of liability for the damages is 100 % of the contract price, which is considered to be reasonable.

4.7.4 Price

The price of the contract is not disclosed in the contract provided. GL GH recommends that the price included in this contract, together with the other OPEX costs, is at a maximum of the OPEX value indicated in the Financial Model.

For the first two years no corrective maintenance is expected from the Contractor and the price should reflect this difference in the Scope of Work during the defect notification period.

Finally, the invoice calculation detail appears twice in the contract (in sections 3.1 and 3.2). ***This should be corrected.***

4.7.5 Conclusion

The main recommendation for the O&M contract would be to give more responsibility to the O&M contractor from the commencement of the contract. The contract contains numerous unbinding references, such as, “the contractor will do what is reasonably possible”. In the interests of giving the Contractor more responsibility, the Contractor’s implication could start from the first energisation of the project with:

- Acceptance of the test results;
- Validation of the punch list;
- Training of the operator with the delivery of the certificate to operate from the Builder;
- Participation in the definition of the spare part minimum initial stock.

With this approach, the Contractor shall be liable for warranties that will be required during the PV plant’s operation. Plus, the warranties shall not be weakened by too many conditions relying on the Sponsor, such as the minimum spare part modification clause in section 2.3, paragraph 3. In this clause, if the Owner rejects the request , the O&M contractor cannot be liable for any issue resulting in the lack of spare parts. It is not acceptable.

GL GH also notes that two major clarifications need to be included in the contract, which are as follows:

- The inverter replacements and warranties detailed (see section 4.7.1) also need to be clarified;
- The module replacement risks (see section 4.7.1) need to be covered by a provision in the OPEX.

5 REVIEW OF THE CONSTRUCTION SCHEDULE

GL GH has been provided with one document detailing the time schedule of the Alpha project construction [5.1]. The document is a .pdf file, extracted from an excel spreadsheet.

The project programme shows the different tasks and the material delivery necessary to achieve construction; all the main tasks required to undertake the construction of a PV plant have been identified in that document, even if GL GH would have expected more detailed planning, including sub-tasks and predecessors.

GL GH's comments on this construction schedule are as follows:

- The date of construction being between April and July, the project should be commissioned at the date of this report. The client has indicated to GL GH that the installation of the PV plant should be completed on 10 August 2011. Some supporting pictures, showing the work progress, have been provided to GL GH by Activ Solar.

- The duration of three months for the construction period seems rather optimistic. The risks of potential delays, with regard to the provided document, are detailed below:
    - The construction tasks start one after another, with a one-week delay. This does not allow for any contingencies in the time schedule;
    - The coordination between the construction contractor and the main contractor will be done jointly by the Sponsor and the Engineering contractor. Therefore, if there is any delay, the responsibility will not be clear and this may lead to further delays;
    - The commissioning period is one week, but proper availability and performance ratio tests need to be performed over more than three weeks to be relevant;
    - The Ukraine Customs Authority may take several days to free the required material;
    - In some cases, different teams (ground movement workers, connecting teams, module installation teams, cable installation teams, etc.) will be working at the same time on the same project. This may lead to Health and Safety issues, as well as organisational ones.

GL GH considers that the construction schedule should be updated to take into account the previous comments and correspond to the announced completion date.

The Alpha Solar project is part of a larger portfolio of four projects. These projects are connected to the same substation, "Tavria Substation". No information has been provided to GL GH about the time schedules for the grid connection and Tavria Substation to be erected. ***Therefore, evidence of the integration of Alpha Solar into more general time schedule should be provided*** Moreover, the other project being built during the winter season, GL GH anticipates difficulties in the construction works that should be reflected in the other SPV's Time Schedule (such as trenching under 5°C).

Finally, there are no payment milestones attached to the planning. The different contracts reviewed have different payment conditions. The main contract for the project's costs is the Contract of Equipment Delivery; this represents 92 % of the CAPEX. The payment is based on delivery of the material to the site. Therefore, if the Sponsor wants to store the modules on-site, it needs to pay 92 % upfront, otherwise the drawdown will follow the pace of the progress of the work on-site. GL GH recommends linking part of the Equipment contract payment to the validation of the Provisional Acceptance. A minimum of 5-10 % is considered the market standard.

6 REVIEW OF THE TECHNICAL INPUTS TO THE FINANCIAL MODEL

This section corresponds to the review of the financial model which was provided by the Client with a view to the project's financing. GL GH has reviewed the spreadsheet containing the Financial Model for the 80 MW portfolio [3.2]. The Alpha Solar project is part of this portfolio and the inputs related to that project are included.

GL GH has reviewed the technical inputs to the Financial Model. The review focuses on appreciation of the following aspects:

- Energy production prediction;
- Feed-in tariff;
- Capital costs;
- Operation and maintenance costs.

As indicated in the list of abbreviations, GL GH has considered an exchange rate of €1 for 10.86 UAH for the project.

6.1 Energy Yield

The Energy Production Assessment for the entire portfolio has been divided into two steps. GL GH has detailed the calculation and results for the P50 and P90 into two separate reports [2.1] and [2.2].

The Energy Production Assessment for the entire portfolio has been divided into two phases. GL GH is going to detail the calculation and results for the P50 and P90 in two separated reports ([2.1] and [2.2]).

The irradiation used in the financial model is 1,442 kWh/m^2. It is referred as "Horizontal Global Irradiation" provided by Enerparc. There is some confusion between "yield" and "irradiation" in the reviewed document. The yield presented in ENERPARC's (subcontracted to SOLPEG) report is 1,331 kWh/kWp. Moreover a loss factor of 0.97 % is applied without further explanations.

The main results of the GL GH analysis ([2.1] and [2.2]) are provided below:

- Global Horizontal irradiation: 1,344 kWh/m^2
- Irradiation on the inclined plane: 1,486 kWh/ m^2
- Energy Yield Factor: 1,109 kWh/kWp
- Performance Ratio: 74.6%

It is concluded that the difference in the between the financial model energy yield and the GL GH estimation is approximately 20%.

For the further year's energy evaluations, the financial model provided uses an average degradation factor for PV module degradation of 0.72 %, per year. During the 10 first years, the degradation considered is 1.1 % and from the tenth year to the eighteenth year the degradation considered is 0.33%. GL GH recommends a yearly continuous degradation of 0.8 % applied since year 0.

6.2 Feed-in tariff

The feed-in tariff used in the Financial Model for the calculation is estimated to be €0.4653/kWh and the price is constant over 18 years. No supporting information has been provided to GL GH for this review. GL GH notes that this tariff is really high compared to other international feed-in tariffs or incentive system that can be found in countries where PV electricity production is well consolidated.

6.3 Investment Costs (CAPEX)

The estimated capital costs in the final Financial Model for the Alpha Project have been provided and these are detailed in Table 6.1.

GL GH has classified the capital costs into 5 groups, according to the Financial Model provided [3.2], as follows:

1) "Imported equipments": the main material needed for the project construction;
2) "Other imported equipment": the cost of grid connection and the cost of development and project management;
3) "Local equipment": represents the missing equipment that will be purchased locally, such as piles, cables, basement for inverters, ASKUE (not defined in the model) and contingencies for other material;
4) "Works": represents the engineering, project design, construction works, electrical installation works, and the video, supervision and lightning.

In the Table 6.1, the column labelled "contracts" are the values of the different groups that have been reviewed in the contracts provided to GL GH.

	TOTAL (k€)	% TOTAL	€/Wp	Contracts
Modules	29,552	44%	1.48	46,080
Mounting systems	2,700	4%	0.13	4,665
Transformer and inverters	6,660	10%	0.33	9,958
Cables	2,000	3%	0.10	5,772
Imported equipment	40,912	61%	2.05	66,475
Connection services	5,279	8%	0.26	N/A
Engineering + development costs	15,206	23%	0.76	N/A
Other imported equipments	20,485	30%	1.02	N/A
Local equipment	792	1%	0.04	N/A
Works	4,268	6%	0.21	1,707
Other	726	1%	0.04	N/A

TOTAL	67,183	100%	3.36	68,182

Data source: Activ Solar

Table 6.1: Capital costs for the Alpha Solar project

The financial model [3.2] is not supported by the contracts reviewed. Therefore, GL GH received complementary information [6.1] from Activ Solar in order to have a better understanding of the financial model and the corresponding contractual structure. For the purpose of clarification, the CAPEX review has been carried out in three steps: (i) A review of the financial model, based on the industry practice; (ii) A presentation of the costs in the contracts and GL GH's understanding of the coverage of these contracts; (iii) A review of the different costs and tasks with the Sponsor and comments on missing information to support the hypothesis provided. The Table 6.1 shows points (i) and (ii). Table 6.2 shows the tasks which were finally included in the Activ Solar Scope of Work.

(i) GL GH's comments about the breakdown of costs in the financial model are as follows:

- The different tasks listed in the financial model cover the CAPEX of a standard PV plant. The only question concerns the cost breakdowns of the initial stock of spare parts required for the O&M phase. ***It should be clarified if this cost is included in the CAPEX or in the OPEX, since it is paid by the Sponsor;***
- The indicated cost of €3.36/Wp is within the highest the range for a 2010 project. It is higher than the market standard for 2011. The Balance of Plant cost is within the average range of expected costs for a 20 MW project. Therefore, the price depends mainly on the module price and on the development costs. The module price is always a market price that has dramatically changed from 2010 to July 2011 (with a range of €1.5/Wp to €0.8/Wp for modules produced in China and provided with Chinese warranties). For this reason, it is very important to have an accurate market opinion of the date of the original module contract price between Activ Solar and the suppliers. Nevertheless, there is usually a renegotiation clause in a module supply contract, which is based on the market price on the day of delivery. As for the development costs, these not only reflect the work undertaken to get the authorisations, but also the defect rate of other projects under development and commercial negotiations between the sponsor and the developer. Although this is a commercial matter, rather than a technical one, GL GH usually expects a value that does not exceed more than 10 % of the total CAPEX costs.

(ii) Section 4 of this report already provided an initial analysis of the prices indicated in the contracts. GL GH's comments about the contract reviewed and how it can fit into the financial model are as follows:

- Some tasks are clearly covered in the contracts, such as the delivery of the main material. However, many tasks are not covered in the contracts reviewed;
- The prices for modules, inverters, cables and mounting systems are very high, compared to the market practice;
- The overall CAPEX of €3,41/Wp does not include all the necessary tasks for completing a PV plant;
- The contract with the constructor, NSI, is not a fixed price; therefore, new costs could be applied during the finalisation of the construction that GL GH was not able to review (this has been also considered in section 4.2).

(iii) A complementary communication [6.1] has been provided to GL GH, explaining some of the differences between the financial model and the contracts reviewed. Table 6.2, below, shows the tasks covered by active solar but not indicated in the contracts of the price between the financial model and the expected breakdown of costs.

	TOTAL (k€)	% TOTAL	€/Wp	Contracts	Activ Solar
Modules	29,552	44 %	1.48	46,080	Included
Mounting systems	2,700	4 %	0.13	4,665	Included
Transformer and inverters	6,660	10 %	0.33	9,958	Included
Cables	2,000	3 %	0.10	5,772	Included
Imported equipment	40,912	61 %	2.05	66,475	Included
Connection services	5,279	8 %	0.26	N/A	Included
Engineering + development costs	15,206	23 %	0.76	N/A	Included
Other imported equipment	20,485	30 %	1.02	N/A	Included
Local equipment	792	1 %	0.04	N/A	N/A
Works	4,268	6 %	0.21	1,707	N/A
Other	726	1 %	0.04	N/A	Included
TOTAL	67,183	100 %	3.36	68,182	

Table 6.2: Capital costs for the Alpha Solar project

GL GH's comments after receiving this document are as follows:

- The minimum stock of spare parts is still not included. ***This should be clarified***;
- This document does not prevent the Sponsor providing a contract addendum, or even a new contract, detailing the tasks covered by active Solar and included in the financial model. ***The documents and contracts specifying the tasks undertaken by Active Solar (and forming part of the financial model breakdown) should be provided to GL GH for review***;
- The works and local equipment tasks and sub-tasks are not covered by a specific contract. Therefore, the risk of cost exceedance for these tasks still exists;
- According to this document, the total Capital expenditure is expected to be €3.66/Wp, instead of the €3.33/Wp indicated in the financial model. Both figures are high for a PV projec compared to the market standard. Moreover, GL GH recommends enclosing a provision for contingencies in the Financial Agreement, thereby limiting the CAPEX engagement for the Lenders.

6.4 O&M Costs (OPEX)

The breakdown cost for the operation and maintenance phase of the Alpha Solar Project is given in Table 6.3. GL GH has not been provided with contracts supporting these costs, since the only O&M contract provided does not include the price.

	TOTAL (k€)	% TOTAL	€/kWp
Material expenses	239	39%	11.96
Electricity for own consumption	98	16%	4.91
Personnel + Social Tax	22	4%	1.12
Security	65	11%	3.27
Maintenance cost	78	13%	3.90
Insurance (0.15%)	101	16%	5.04
Land Lease	7	1%	0.34
Other	6	1%	0.30
TOTAL	**617**	100%	30.85

Data source: Activ Solar

Table 6.3: O&M costs for the Alpha Solar PV plant

GL GH has not been provided with supporting information to comment on the OPEX costs, such as contracts and the land lease, for example. Nevertheless, GL GH would comment on the above figures, as follows:

- The list of tasks seems comprehensive, mainly because the maintenance tasks and material costs could cover a wide range of services;
- ***The electricity for own consumption should be clarified, since it seems to be rather a unusual very high cost***;
- The insurance costs are expected to be either around 1.5 % or the yearly revenue of the Plant, depending on the insurance contracted. Given the very high feed-in tariff GL GH considers that this cost is higher than expected in other European countries. GL GH recommends that the Insurance Advisor also checks this figure;
- The land lease cost seems rather low (around 50 times lower than a western European country's cost). ***The land lease contract should be provided to GL GH for review, to check this cost***;
- The OPEX figure of €30.85/kWp seems very low, compared to the market standards;
- The contingencies provision represent 1 % of the OPEX, when it is usually expected to be around 10 %;
- The cost of this model should be supported by the contracts that will eventually be signed;
- Two specific important tasks should be reviewed when the O&M contracts are finalised (see section 4.7):
  - *Inverter replacements and warranty management:* It should be clarified which option or a combination of them is going to be considered: (i) It is included in the O&M contract; (ii) There is a contract between the Sponsor and the inverter manufacturer; (iii) It is covered by a maintenance reserve account (MRA) and when the contract

covering the inverter replacement is limited beforehand, the MAR should be prepared for the end of the agreement.

- *Module replacement management:* since this is not included in the O&M contract, this has to be addressed by means of an adequate initial stock and the labour cost for replacement.

REFERENCES

[2.1] GL GarradHassan report 230050-ESBA-R-02-A, *in progress*

[2.2] GL GarradHassan report 230050-ESBA-R-03-A, *in progress*

[3.1] Photon international, November 2010

[3.2] Activ Solar Financial Model v01.xls, provided on 20th July 2011

[5.1] 5 - (The schedule of construction work), issued on 15th June 2011

[6.1] Email from Serguey Nadtochiy, “RE: question about financial model”, dated 09th August 2011